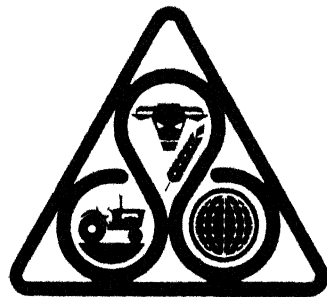


STUDIES IN RURAL FINANCE

AGRICULTURAL FINANCE PROGRAM



Department of Agricultural Economics and Rural Sociology

**THE OHIO STATE UNIVERSITY
COLUMBUS, OHIO
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AGRICULTURAL FINANCIAL PROJECTIONS:
MODELS AND METHODS

Proceedings of a Workshop held at the Sixth District
Farm Credit Banks, St. Louis, November 2, 1983.

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Evaluating Financial Markets
For Agriculture

P R E F A C E

This publication contains papers presented at a workshop held in conjunction with the 1983 annual meeting of Regional Research Project NC-161, "Evaluating Financial Markets for Agriculture." The seminar was designed to include selected examples of the different approaches being used in the private sector, the USDA and land grant institutions to forecast economic and financial trends in the U.S. farming sector. These approaches range from qualitative, judgemental techniques to highly complex econometric models. Methods used and reports generated also vary according to the needs of a wide range of users--producers, input suppliers, processors, government policy makers, and many others with a specific or general interest in agriculture. The task of forecasting is also complicated by the increased instability in national and international commodity and financial markets in recent years.

Cooperating agencies in the NC-161 project are: the agricultural experiment stations of Arkansas, Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Nebraska, New York, North Dakota, Ohio, Oklahoma, and Texas; Board of Governors of the Federal Reserve System; Federal Reserve Bank of Kansas City and ERS; USDA. Dr. Donald Anderson, North Dakota State Agricultural Experiment Station, serves as Administrative Advisor.

A number of individuals and organizations deserve appreciation for their contributions to this seminar and other activities of NC-161. Michael Boehlje, John Brake and Jerome Stam served as a program planning committee to organize this seminar. Kenneth Obrecht handled local arrangements on behalf of the Sixth District Farm Credit Banks who graciously hosted this meeting. Appreciation is also expressed to the Farm Foundation for their financial support. Finally, a special thanks is extended to the seminar participants who prepared and presented the papers that follow.

Warren F. Lee,
1983 Chairman
NC-161 Research Committee

TABLE OF CONTENTS

	PAGE
Relationship between Macroeconomic Factors and Agriculture: A Brief Wharton Econometric Specification by: Tom Runiewicz	1
Forecasting the Agricultural Economy by Looking at the Whole Picture by: William C. Senior	12
Modeling Needs for Macroeconomic and Aggregate Analysis Of the Farm Economy by: Linwood A. Hoffman and Ronald L. Meekhof	20
An Overview of the Development and Applicability Of the Comgem Model by: John B. Penson, Jr.	31
The Theoretical Macroeconomic Structure of The Comgem Model by: Dean W. Hughes	56
The Theoretical Structure of Farm Supply Response and Price Determination in Comgem by: Robert F.J. Romain	79
The MSU Agriculture Model by: Thomas Christensen	99

RELATIONSHIP BETWEEN MACROECONOMIC FACTORS AND AGRICULTURE:
A BRIEF WHARTON ECONOMETRIC SPECIFICATION

BY
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**RELATIONSHIP BETWEEN MACROECONOMIC FACTORS AND AGRICULTURE:
A BRIEF WHARTON ECONOMETRIC SPECIFICATION**

The farm income sector of the Wharton Agriculture Model is a recursive set of equations that takes account of every individual sector within our agriculture service. Currently our domestic service is broken down into seven commodities:

- . Foodgrains
- . Feedgrains
- . Oil seeds
- . Cotton
- . Dairy
- . Red meats
- . Poultry

In this paper, we will review the cotton sector as an example of our model. Our investigation begins with identifying the major U.S. macroeconomic factors that directly affect the cotton market. Once these factors have been established, we will study the relationship between cotton and farm income. While other commodities also influence farm income, we will review only cotton and its linkage to cash receipts.

To determine farm income there must also be an effective method of estimating production expenses. The next step of our analysis will be to determine the extensive relationship between U.S. macroeconomic factors and farm production expenses. Included in this study is a disaggregated breakdown of farm prices and economic relationships.

Cotton Sector

The linkage between macroeconomic variables, provided by the Wharton Quarterly Model, and the agricultural sector's Cotton Model is fairly substantial. Our Cotton Model is a set of fully simultaneous equations that forecast supply, demand, and prices.

The export equation is one in which we have not only found a strong relationship between cotton exports and price but exchange rates as well. Equation 1.0 shows the functional relationship between these variables.

$$1.0 \quad - \left(\frac{\text{COLPMME116}}{\text{REXWAGSM}} \right) f = \text{COLMX}$$

where: COLMX = Exports, cotton

COLPMME116 = Memphis price, cotton

REXWAGSM = Exchange rate, weighted average in \$/local currency

In our model, REXWAGSM is a weighted-average currency exchange from Canada, the United Kingdom, France, Italy, Germany, and Japan. As the dollar becomes stronger, cotton becomes more costly overseas and therefore demand declines. Hence, the coefficient is negative.

Cotton mill demand is also directly related to economic factors. Equation 2.0 shows this relationship.

$$2.0 \quad (\text{CENC.TCPOP}) f = \text{COLDM}$$

where: COLDM = Mill demand, cotton

CENC = Personal consumption expenditure, clothing and shoes

TCPOP = Population

The coefficients for Equation 2.0 are positive owing to the empirical relationship that stronger incomes and larger populations increase mill demand.

Finally, we have found a strong link between cotton prices and real interest rates. As real interest rates increase, opportunity and carrying costs rise, making the commodity less desirable. This explains the negative relationship in Equation 3.0.

$$3.0 \quad - \left(\frac{\text{FRMPRIME}}{\text{PCW}} \right) f = \text{COLPMME116}$$

where: COLPMME116 = Memphis price, cotton
 FRMPRIME = Prime rate, leading banks
 PCW = CPI, all items

The equations above define our functional specification between U.S. macroeconomic factors and the cotton market. However, there must be additional linkages to incorporate cotton within farm revenue (farm income sector).

Farm Income (Cash Receipts)

The revenue side of our Farm Income Model is broken down into a number of sections which are fed from the basic supply/demand interaction of commodities. Since our example is a focus on the cotton market, the main issue is to establish the relationship between prices, cotton demand, and cotton cash receipts. Equation 4.0 demonstrates this functional relationship.

$$4.0 \quad (\text{COLPFAU}, \text{COLDM}, \text{COLMX}) f = \text{CRCOC}$$

where: CRCOC = Cash receipts, cotton
 COLPFAU = Farm price, cotton
 COLDM = Mill demand, cotton
 COLMX = Exports, cotton

The cotton sector along with other commodities such as food grains, feed grains, and oil seeds are summed to calculate total crop cash receipts. This linkage is defined in Identity 5.0.

$$5.0 \quad \text{CRCOC} + \text{CRCFG} + \dots = \text{CRC}$$

where: CRC = Cash receipts, all crops
 CRCFG = Cash receipts, feedgrains
 CRCOC = Cash receipts, cotton

The total cash receipt component is the summation of both crop and livestock receipts. This is expressed in Identity 6.0.

$$6.0 \quad \text{CRC} + \text{CRK} = \text{CR}$$

where: CR = Cash receipts, total
 CRL = Cash receipts, all livestock

While it can be seen that economic factors will have an indirect effect on farm revenue, they also play a very strong role within the farm expense side. The last section of this paper will present a disaggregated specification of Wharton's farm production sector and its linkage to macroeconomic information.

Production Expenses

Wharton uses a fairly extensive technique to fully utilize information generated by the macroeconomic sector to forecast farm production expenses. To initially identify our general relationship, farm expenses are defined as a function of production prices and production activity. Equation 7.0 demonstrates this relationship.

$$7.0 \quad (PFPW^*, AP, \dots) f = EXFP$$

where: EXFP = Production expenses, total farm

AP = Acreage planted, total

PFPW* = Index of prices paid by farmers

Major attention is placed on the components of variable PFPW*, the index of prices paid by farmers. To further disaggregate this variable, we focus on Equation 8.0.

$$8.0 \quad (PFPIITWR^*, PFPL^*) f = PFPW^*$$

where: PFPIITWR* = Prices paid by farmers for all production items,
interest, wages, and taxes.

PFPL* = Prices paid for farm family living

As shown in Equation 9.0, variable PFPL* is directly linked with an overall CPI index.

$$9.0 \quad (PCW) f = PFPL^*$$

where: PCW = Consumer Price Index, all items.

Prices paid for production items can be further disaggregated into detailed components of agricultural expenses, where wages, taxes, interest rates, and other production items are separated. This is explained in Equation 10.0.

$$10.0 \quad (PFPPPI^*, PFPTX^*, PFPI^*, PFPWR^*) f = PFPPPIITWR^*$$

where: $PFPPPI^*$ = Prices paid for all farm production items

$PFPTX^*$ = Prices paid for farm taxes

$PFPI^*$ = Prices paid for farm interest

$PFPW^*$ = Prices paid for farm wages

To show the linkages between the components in Equation 10.0 and macroeconomic factors, we present Equations 11.0 through 13.0.

$$11.0 \quad (WRCAG\$) f = PFPWR^*$$

where: $WRCAG\$$ = Employee compensation, agriculture

$$12.0 \quad (FRMRMW) f = PFPI^*$$

where: $FRMRMW$ = Home mortgage rates, weighted average of new
and existing homes

$$13.0 \quad (TXCBS\$) f = PFPTX^*$$

where: $TXCBS\$$ = Tax receipts, all governmental

While the breakdown in Equation 10.0 is fairly straightforward, further breakdown of $PFPPPI^*$ is needed. Disaggregating this variable requires a sig-

nificant amount of economic input. At Wharton, the agricultural group has attempted to do this through the specification in Equation 14.0.

$$14.0 \quad PFPPI^* = f(PFPF^*, PFPFL^*, PFPZ^*, PFPFE^*, \\ PFPFM^*, PFPAT^*, PFPTM^*, PFPOM^*, \\ PFPBF^*, PFPSC^*, PFPS^*, PFPCM^*)$$

where: PFPF* = Price paid for feed
 PFPFL* = Price paid for feeder livestock
 PFPZ* = Price paid for fertilizer
 PFPFE* = Price paid for fuel and energy
 PFPFM* = Price paid for farm and motor supplies
 PFPAT* = Price paid for autos and trucks
 PFPTM* = Price paid for tractors and machinery
 PFPOM* = Price paid for other machinery
 PFPBF* = Price paid for buildings and fencing
 PFPSC* = Price paid for services and rent
 PFPS* = Price paid for seed
 PFPCM* = Price paid for agricultural chemicals

Note: All the above are indexes

The equation above explains our method of disaggregating farm price indexes. However, we must go one step further to show how macroeconomic components are utilized in agricultural cost forecasting. Equations 15.0 through 26.0 present a detailed review of the linkages between economic conditions and the variables in Equation 14.0. While these specifications may seem simplistic, consideration must be given to economic variables that are easily retrieved from nonagricultural forecasts. The difference between econometric

building by the theorists versus model building by the pragmatists can sometimes be substantial. I hope this paper gives you at least a quick review of how practical model builders try to specify a complex economic system.

$$15.0 \quad PFPF^* = f(CORPMZYCH, SOMPM44DE)$$

where: $PFPF^*$ = Index of price paid for feed

$CORPMZYCH$ = Corn price

$SOMPM44DE$ = Soybean meal price

$$16.0 \quad PFPFL^* = f(BECPF, HOGPF)$$

where: $PFPFL^*$ = Index of price paid for livestock

$BECPF$ = Beef price

$HOGPF$ = Hog price

$$17.0 \quad PFPZ^* = f(OPECPRICE, PXUGMG)$$

where: $PFPZ^*$ = Index of prices paid for fertilizer

$OPECPRICE$ = Official OPEC price of crude

$PXUGMG$ = Sector price deflator for mining

$$18.0 \quad PFPFE^* = f(OPECPRICE, PDCENG)$$

where: $PFPFE^*$ = Index of prices paid for fuel and energy

$PDCENG$ = Producer Price Index for gas and oil

$$19.0 \quad \text{PFPFM}^* = f(\text{PWDMFD})$$

where: PFPFM^* = Index of prices paid for farm and motor supplies

PWDMFD = Producer Price Index for durables

$$20.0 \quad \text{PFDATA}^* = f(\text{PWDMFD})$$

where: PFPAT^* = Index prices paid for autos and trucks

PWDMFD = Producer Price Index for durables

$$21.0 \quad \text{PFPTM}^* = f(\text{PWDMFD})$$

where: PFPTM^* = Index of prices paid for tractors and machinery

$$22.0 \quad \text{PFPOM}^* = f(\text{PWDMFD})$$

where: PFPOM^* = Index of prices paid for other machinery

$$23.0 \quad \text{PFBBF}^* = f(\text{PWDMFD})$$

where: PFBBF^* = Index of prices paid for building and fencing

$$24.0 \quad \text{PFPS}^* = f(\text{AP})$$

where: PFPS^* = Index of prices paid for services and rent

AP = Acreage planted

$$25.0 \quad \text{PFPS}^* = f(\text{WHEPF}, \text{CORPF}, \text{SOYPF})$$

where: PFPS^* = Index of prices paid for seed

WHEPF = Wheat prices

CORPF = Corn prices

SOYPF = Soybean prices

$$26.0 \quad \text{PFPCM}^* = f(\text{OPECPRICE})$$

where: PFPCM^* = Index of prices paid for chemicals

FORECASTING THE AGRICULTURAL ECONOMY
BY LOOKING AT THE WHOLE PICTURE

BY
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FORECASTING THE AGRICULTURAL ECONOMY
BY LOOKING AT THE WHOLE PICTURE

William C. Senior ¹/_—

The Kiplinger Agricultural Letter uses the judgmental forecasting technique in supplying its subscribers with information designed to assist them in achieving maximum returns from their various agribusiness ventures. About two-thirds of these subscribers own or operate a farm or ranch. The remaining one-third consists mainly of bankers and businessmen who deal with farmers in one way or another.

Today, most subscribers look to Kiplinger for guidance on price and income trends as seen from a Washington viewpoint. In nearly all instances, people do not buy this newsletter for specific advice on speculating about daily price movements. Instead, they read it for more of an overall picture...conclusions that are put together after looking at many types and sources of information.

In order to give some insight into how the Kiplinger organization operates, let me share a little history with you. The Kiplinger Agricultural Letter was started 54 years ago as a publication that reported on the workings of the Federal Farm Board. Over the years it has moved from doing a straight reporting job on agricultural happenings in Washington to offering judgments...first on Washington matters such as legislation forecasts and the interpretation of federal regulations. Then it moved on to comments regarding supply and demand factors. And finally to general forecasts of the farm economy and farm commodity prices.

This evolutionary process came about because the readers of the Kiplinger Agricultural Letter asked for it. The subscribers wanted something more than a straight reporting of the facts. They wanted to know what the Kiplinger organization thought about certain things after its members had participated in many conversations with experts on a particular subject. A publication that exists on paid subscriptions gives its readership what it wants...or it doesn't survive very long.

To completely understand how Kiplinger forecasts are put together, one needs to realize that Kiplinger staff people are reporters and editors. While they may have degrees and specific training in economics and forecasting, they all function as editors rather than as analysts.

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Perhaps the best description of how Kiplinger editors operate was written by Mr. W.M. Kiplinger, founder of the organization many years ago. He said...

"We walk. We talk. We telephone. We ask questions. We listen. We swap views. We go through many Washington doors. We get many pieces of information, advice, guidance, points of view, opinions, forecasts. We weigh all these in our minds. We sort and sift. We check them against each other. We practice skepticism. We apply the tests of facts and reason against rumors. We argue among ourselves. Then finally...we put everything together into a picture and write it for our subscribers."

As for whom we talk with: We try to talk with everyone who might have a bearing on a particular subject. When the subject happens to be the price of a major commodity, we visit with the statisticians and analysts whom we have found to be most knowledgeable in the field. Then to climatologists about future weather trends that might impact on supply or demand. Then to government policymakers who might play a role in developing programs that would affect the price of the commodity in question. Also to congressional leaders who would have a hand in any new legislation that might bring about a change in the outlook somewhere down the road. We talk with the buyers of the commodity...the processors, the shippers, the final consumers.

Some of the information we get will be conflicting and will indicate prices going in different directions. Thus, discrimination has to be used. One must be selective. Frankly, we in the Kiplinger organization believe that it is part of our job to be discriminating on behalf of our readers. We try to ask our sources the questions a reader might ask if the reader had access to these people. We then sift through the information we collect, boil down the important parts and distill it for our readers.

In part, the Kiplinger Agricultural Letter and other Kiplinger Letters report and interpret what others are saying about various things. But in most instances, we add a touch of our own impressions based on long years of experience.

Kiplinger Agricultural Letter forecasts are nearly always the result of several major steps: The first step is the collection of information from every possible source within reason. In nearly all instances, one source will be the federal government...mainly the U.S. Department of Agriculture. We depend on USDA and other government agencies for basic statistical information. Also, we try to get the thinking of top government experts on the subject in question.

Through personal interviews, and with the promise of anonymity, we are often able to get a little something extra...something more specific than usually appears in published reports from government agencies. For example: An outlook report from USDA may give a fairly wide range of prospective prices for a given commodity. Usually the forecasts

are made in terms of quarterly averages. Personal conversations often enable us to determine if the authors of the forecast favored the upper end or the lower end of the range. Also, we are often able to get opinions on possible weekly or monthly price movements. In most cases, it is more beneficial to our readers if they have a feel for which way prices will go during a calendar quarter or crop year...than to simply have a quarterly or season-average price forecast.

On the major commodities such as cattle, hogs, corn, soybeans and wheat...we also talk with experts at some of the Land Grant colleges. These are people whom we have come to know and respect over the years as good solid forecasters. By personal experience, we have come to conclude that certain livestock economists do a better job forecasting cattle prices than they do hog prices and vice versa. By the same token, some crop analysts are better at soybeans than they are at corn.

In recent years, we have been spending more time talking with corporate or private-sector economists...people who work with grain companies, packing plants, feedlots, farm supply businesses and so on. Quite often we talk with top agribusiness executives in addition to company economic analysts. These corporate decision makers bring a different flavor to the outlook. In a sense, it is more practical and less academic. Many of these wily old veterans have a gut feel for what is happening, based on their long years of experience. They sometimes come up with conclusions that differ from what their economists and econometric models tell them. Usually the corporate chieftain differs because his experience helps him to anticipate how farmers and others will react to a certain set of circumstances...something mathematical formulas are incapable of doing. He takes into account how farmers will perceive current happenings, and doesn't make his decisions solely on what the numbers say that farmers will do.

Once the information has been gathered, the editor sets about analyzing and distilling. The idea is to cut away the fat and keep the muscle. Where possible, everything is reduced to a common denominator.

If all the experts we have talked with happen to be in agreement, there is no need to go any further. You have the forecast. In 30 years of doing this kind of work, I can recall this happening only once. That case involved beef cattle prices in the late 1960s. Everyone we talked with said cattle prices would be rising. Everyone was wrong.

The usual course of events is that there will be DISagreement among analysts...at least in degree, if not in direction. This is where the Kiplinger editor sticks his neck out and applies some judgment. He decides whether to go with the forecaster from USDA, the one from Texas or the one from Chicago. And he does this pretty much based on experience...his own and that of his colleagues.

It is at this point in the process that the Kiplinger Agricultural editor also brings into play all the general knowledge he has at hand within the Kiplinger organization. Things such as the general economic outlook, the prospects for changes in interest rates, where the value of the dollar might be headed and so on. Also any probable upcoming political decisions

that would have an effect on future commodity price movements than do supply and demand...at least in the short run.

In recent years, the demand for farm commodities and the prices of commodities have become more and more intertwined with the workings of the overall economy. Not just the U.S. economy but the global economy. Thirty years ago you could make some simple estimates of prospective beef supplies for the months ahead, put a number on demand by multiplying the population by per capita consumption...and use these to make a pretty good cattle price forecast. If you thought there was going to be recession, you shaded the price forecast a little. On the other hand, if business was booming and per capita incomes rising...you added 50¢ a cwt. Twenty-five and thirty years ago, prices of the major crops moved in a fairly narrow band, and it was easier to be reasonably accurate in forecasts. In those days of mandatory programs for the major crops, market prices never strayed very far from the loan level. The accuracy rate on price forecasts for such crops was phenomenal.

Today, things have changed tremendously. It is necessary to be much more precise in estimating supply and demand. We need to have more detailed information on where unemployment is headed and what real incomes are going to be. We need a good handle on interest rate trends, loan availability and so on. Today, the price of corn on U.S. farms depends greatly on export demand. And export demand depends on the economies of countries beyond the oceans, the value of the dollar against other currencies and the trade policies of the U.S. and its trading partners.

The downward trend in grain prices that started in 1980 and continued through 1982 was the result of many things...a partial embargo on grain to Russia, the rising value of the U.S. dollar against other currencies, a world recession...to name a few. These had more impact on corn prices at the farm gate than did U.S. farm policy and domestic demand.

Quite frankly, one of the more important factors that we detect as having a major effect on the financial fortunes of farmers is how the general population feels. The expectations that people have and, in particular, their confidence level.

For example: The expectations of U.S. family shoppers seem to have a great deal to do with the demand for beef in this country. When American shoppers are doing well economically and feel they will be doing well in the future...the tendency is to buy more and better cuts of beef. Simply having the money available sometimes isn't enough to spark beef buying. If these potential beef buyers are not confident in their expectations about the future, they tend to be very conservative in their shopping habits.

The expectations and confidence levels of people around the world play a major role in the expansion or contraction of farm exports. When the populations and governments of the developing countries are in an optimistic mood, they are quite willing to spend more money to upgrade diets. This was true throughout the decade of the seventies. Despite shocks from the oil price escalation, people in general tended to remain fairly optimistic in their expectations. Most were confident that everything would work out to their satisfaction.

But as the decade of the 1980s began, an accumulation of sour economic news and other factors prompted much of the world's population to turn pessimistic...or at least become more cautious. Suddenly there was a reluctance to further upgrade diets...probably stemming from a fear of being unable to pay the bill. As a result, the world demand for grains and oilseeds contracted. And the contraction was more than some of the factors that can be put into numerical terms seemed to indicate.

While our subscribers, in general, tend to pressure us for short-term forecasts in every issue, many tell us that our greatest service is in calling major turns in long-range outlook and in the identification of new trends. Here we pay a good bit of heed to longer term cycles. Not just the all-familiar cattle cycle or the hog cycle...but also long-range weather cycles...the 10-year cycle, the 22-year cycle and so on. While these long-range weather cycles are not very precise in the forecasting of drought and poor crops, they do give some very strong clues as to when such are likely to occur within a 2 or 3-year period. If nothing else, they alert the observer to be on the lookout for early signs of abnormal weather.

To give you an idea of some of our longer term forecasts and the reaction of our readers to them...let me cite the following:

In the spring of 1977, the Kiplinger Agricultural Letter said that cattle prices would explode by 1980. We received a fair amount of accolades 12 to 24 months later when cattle prices literally went through the roof. But in 1981 and 1982 when cattle prices fell short of our readers' expectations, some of these same readers placed the blame on us. Their line of reasoning went this way: Prices in 1981 and 1982 would not have been so low if Kiplinger hadn't written so much about how good things were going to be. In other words, they felt that optimistic Kiplinger forecasts prompted too many cattlemen to boost production, and there was too much beef around for the weakening demand.

Back in 1969, the Kiplinger Agricultural Letter said that land prices were poised for a tremendous surge during the 1970s. While we didn't have the nerve to spell it out then, our thinking at that time was that land prices would probably double during the decade of the 1970s...a result of expanding export sales and a higher inflation rate.

Well, exports during the seventies didn't just expand...they exploded. Inflation didn't move higher...it skyrocketed. As for land prices, they didn't double...they tripled. Over the years we have received some very kind comments about that 1969 land price forecast. And we have also received a fair number of kudos for saying several times in the early seventies that farm exports were in for substantial expansion.

But over the past couple of years, subscribers have given us plenty of flak for not foreseeing that President Carter would slap a partial embargo on grain to Russia in January 1980. More than a couple have let us know in very specific terms that this is what they pay us to do.

Since news reporting and news analysis make up such an important part of the service we offer, our forecasts are monitored constantly and are subject to revision every time we publish. However, this does not mean that we are changing direction every two weeks. Experience has taught us that you should have solid reasons for making changes in forecasts...things such as new data or proof of happenings that will affect supply and demand. Switching forecasts on rumor or whim usually gets the forecaster into trouble.

As we think ahead to the future, it is our opinion that worldwide events are going to play an even larger role in forecasting what is coming for U.S. agriculture. Over the coming decade, export demand for the grains and oilseeds will play an ever-expanding role in what happens to domestic supplies and prices. This means judgmental forecasters and others will have to keep a closer watch on world financial markets...interest rates, debt structure of customer countries and the value of the dollar against other currencies. And it means constantly monitoring energy prices and the effects that changes might have on the budgets of various countries.

Also of great importance: Anticipating what will be happening in trade negotiations between the United States and other countries. Answering such questions as: Will the Japanese allow more beef and citrus into their country from the U.S.? Will the European Community ease up in its subsidization of farm exports...or will the U.S. be forced into retaliating by launching its own export subsidy programs? And what about future dealings with the Soviets? Or the Chinese? All these things figure prominently into the outlook for U.S. agricultural exports.

On the domestic front: One has to keep an ever-watchful eye on what may happen because of changes in disposable incomes or health considerations. Will limited water supplies force changes in domestic farm production? Might new environmental rulings bring changes in systems of farming? How will new approvals or bans of pesticides or animal drugs affect agricultural output? And what about the eventual effects of complete deregulation of transportation?

Last but not least...what about future government farm programs? In our opinion, the next year or two will be a watershed period for farm programs. Some new innovations are likely to start showing up in 1985. There are a few farm legislation experts who say that in 1985 we will have to choose between programs with mandatory controls...or no programs at all. Frankly, we don't think this will be the case. There will be room for something in between these two extremes. But as for just what form this might take, it is too early to say with any degree of certainty.

We are starting to pick up some clues about future farm programs though...through numerous conversations with senators and congressmen who have an interest in such matters. Right now, there are some pretty strong signs that future farm programs should not have loan rates and target prices set so high that they tend to subsidize the expansion of grain and oilseed production in other countries. We also detect a growing skepticism about the wisdom of having target prices, etc., on an upward

escalator...or tying them to inflation. Instead, there seems to be more interest about hooking loan rates and targets (if any) to the average market price of the past two or three years. The hope here is to keep price supports more closely in tune with the real world.

Interested persons often ask us: Does Kiplinger have any plans to develop its own econometric model to replace, or become an ingredient of, judgmental forecasts. Now we certainly have nothing against econometric models. Some of our best sources use this method of forecasting, and, of course, this gets cranked into the judgmental forecasts that we publish. But to the best of my knowledge, we have no plans to build a model at this time. The main reason is that econometric modeling doesn't fit into the way we do business.

Kiplinger is still a newsletter publishing company. Our staff people are primarily reporters and editors. As we assess our role in the dissemination of economic and other information to the agribusiness community, it is our conclusion that we can offer the greatest service by continuing on our present course.

MODELING NEEDS FOR MACROECONOMIC AND
AGGREGATE ANALYSIS OF THE FARM ECONOMY

BY

LINWOOD A. HOFFMAN AND RONALD L. MEEKHOF

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Introduction

The Economic Research Service has recently redirected resources to expand its analysis of factors affecting aggregate agricultural demand and supply, and sector performance. The newly established Finance and Aggregate Analysis Branch (FAA) is charged with analyzing and reporting on the effects of macroeconomic policies and developments on the farm economy; conditions affecting the cost and flow of resources to the farm sector, and factors influencing the sector's wealth, growth, rates of return and other financial characteristics (figure 1). These responsibilities are divided into three functions: situation and outlook analysis, policy or staff analysis and basic research.

FAA is an integral part of the ERS situation and outlook program. The creation of the Branch will in part ensure that the short and long term outlook for commodity markets and sector performance is consistent with domestic and international macroeconomic developments. The remainder of this paper will focus upon FAA's structure, objectives, and types of models currently in use or being developed.

Branch Structure

The Finance and Aggregate Analysis Branch consists of four sections: National Aggregate Analysis, Macroeconomic Analysis, Agricultural Finance, and Credit and Tax Policy. Section objectives are listed in figure 2.

National Aggregate Analysis Section

A major task of this section is to integrate analyses of general economic developments, agricultural markets, agricultural policy and farm financial conditions as they influence the overall farm economy. It draws on research conducted elsewhere and has responsibility to develop indicators which best reflect current and longer term conditions underlying aggregate demand, supply, and sector performance. Major types of indicators include measure

FIGURE 1. LINKAGES OF THE MACROECONOMY AND U.S. AGRICULTURE

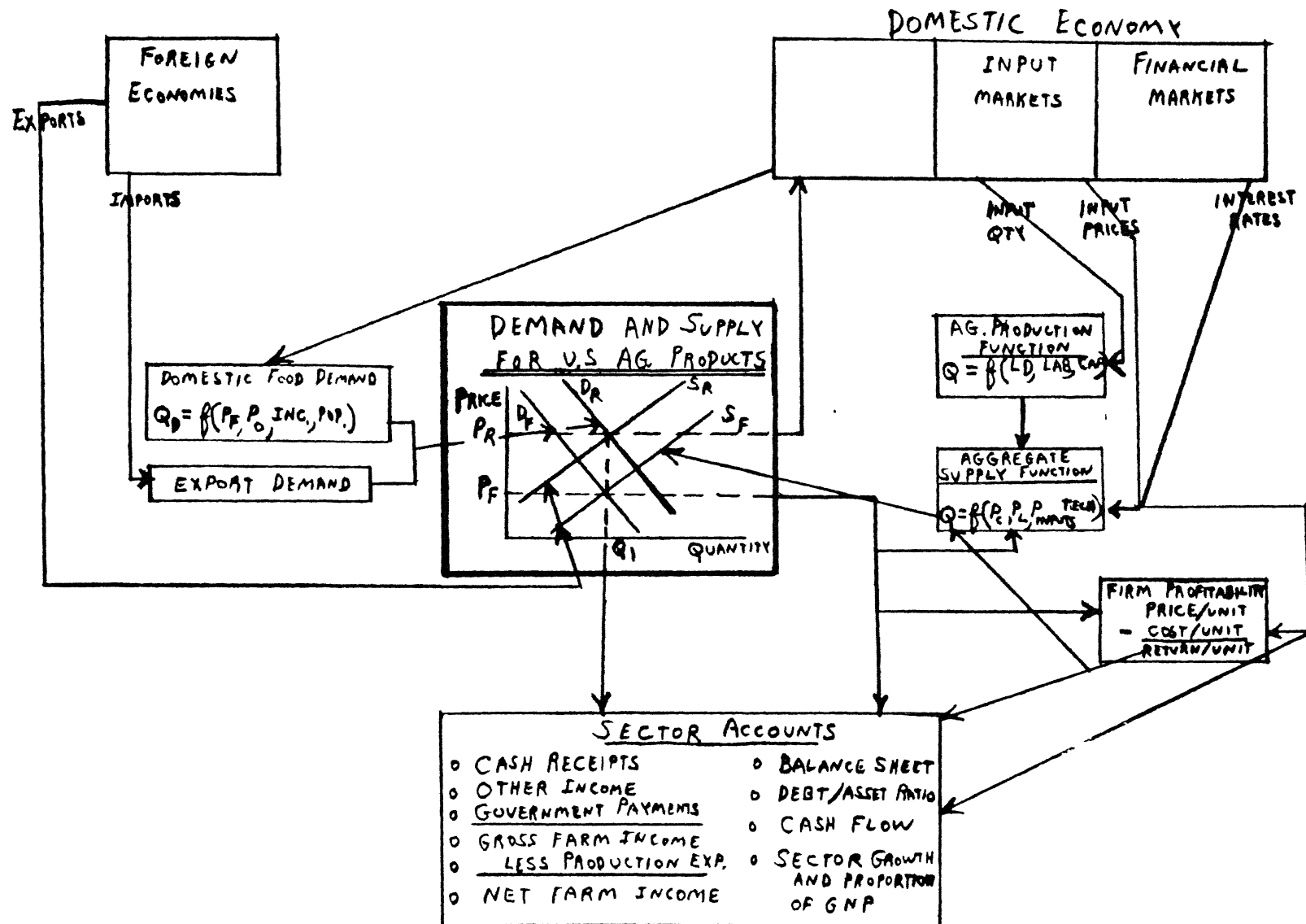


FIGURE 2. OBJECTIVES OF THE FINANCE AND AGGREGATE ANALYSIS BRANCH

NATIONAL AGGREGATE ANALYSIS SECTION

1. COORDINATE THE AGRICULTURAL OUTLOOK PUBLICATION
2. REVIEW SEMI-ANNUAL AG SECTOR FORECASTS
3. PREPARE INTEGRATED ANALYSES OF THE FARM SECTOR
4. CONDUCT RESEARCH ON DEVELOPMENT OF AGGREGATE INDICATORS OF THE FARM SECTOR
5. DEVELOP A QUARTERLY MODEL OF KEY AGRICULTURAL COMMODITIES TO BE USED FOR SITUATION AND OUTLOOK AND STAFF ANALYSES

MACROECONOMIC ANALYSIS SECTION

1. MONITOR AND EVALUATE MACROECONOMIC AND POLICY DEVELOPMENTS
2. EVALUATE THE IMPACT OF MACROECONOMIC AND POLICY DEVELOPMENTS ON AGGREGATE AGRICULTURAL INDICATORS
3. QUANTIFY RELATIONSHIPS BETWEEN THE AGRICULTURAL SECTOR AND DOMESTIC AND INTERNATIONAL ECONOMIES
 - A. EVALUATE THE IMPACT OF DOMESTIC MONETARY POLICY CHANGES ON FINANCIAL CONDITIONS OF THE FARM SECTOR
 - B. ASSESS THE IMPACTS OF ECONOMIC AND POLICY DEVELOPMENTS ON EXCHANGE RATES AND EXPORT DEMAND FOR U.S. FARM PRODUCTS
4. ANALYZE THE PERFORMANCE OF THE FOOD AND AGRICULTURAL SECTOR RELATIVE TO OTHER SECTORS OF THE ECONOMY
5. ANALYZE THE REGIONAL AND NATIONAL IMPACTS OF CHANGES IN AGRICULTURAL POLICIES
6. ASSESS COMPATIBILITY OF USDA DATA WITH THE NIA ACCOUNTS

FIGURE 2. OBJECTIVES OF THE FINANCE AND AGGREGATE ANALYSIS BRANCH, CONTINUED

AGRICULTURAL FINANCE SECTION

1. MONITOR AND ANALYZE THE ECONOMIC AND FINANCIAL CONDITIONS OF AGRICULTURE AND ASSESS THE IMPLICATIONS TO THE SECTOR'S LIQUIDITY, RISK, ABILITY TO SERVICE DEBT AND OTHER INDICATORS
2. ANALYZE THE FINANCIAL STRUCTURE OF AGRICULTURE
3. DESCRIBE AND ANALYZE THE FACTORS THAT DETERMINE FARMER'S USE OF CREDIT
4. DESCRIBE AND QUANTIFY ECONOMIC FORCES AFFECTING AGGREGATE AGRICULTURAL INVESTMENT
5. ANALYZE RELATIONSHIPS BETWEEN AGGREGATE INVESTMENT AND AGGREGATE SUPPLY
6. ASSESS IMPLICATIONS OF CHANGES IN OWNERSHIP AND CONTROL OF AGRICULTURAL ASSETS

CREDIT AND TAX POLICY SECTION

1. MONITOR AND EVALUATE CHANGES IN MARKET CONDITIONS (INCLUDING LEGISLATIVE AND ADMINISTRATIVE CHANGES) AS THEY AFFECT THE COST AND AVAILABILITY OF CAPITAL TO LENDERS
2. ASSESS: LENDERS' RISK MANAGEMENT ALTERNATIVES, INNOVATIVE DEBT FINANCING TO FARMERS AND IMPACTS OF FINANCIAL DEREGULATION TO LENDERS.
3. DEVELOP A DISAGGREGATED MODEL WHICH STRESSES THE SUPPLY AND DEMAND FOR CREDIT WITHIN THE AGRICULTURAL SECTOR
4. EVALUATE THE IMPACT OF NEW AND EXISTING AGRICULTURAL TAX PROVISIONS ON INVESTMENT STRATEGIES, FIRM GROWTH, EQUITY TRANSFERS, LAND VALUES AND ALTERNATIVE METHODS OF ACQUIRING CAPITAL.
5. ANALYZE EFFECTS OF PUBLIC CREDIT PROGRAMS ON THE FARM SECTOR
6. EVALUATE IMPACTS AND EXTENT OF SUBSTITUTION IN COVERAGE PROVIDED BY FMHA EMERGENCY DISASTER LOANS AND FEDERAL CROP INSURANCE

of performance of the domestic economy, financial markets, export markets, sector productivity, and financial stock and flows in the farm sector. Understanding of how these indicators respond to, reflect, and influence aggregate farm sector economic conditions will be an important component in long term sector outlook. The capacity for providing internally consistent, short term quarterly forecasts of commodity supply, demand and prices, farm income, and food prices is being developed and will be an important tool for staff analyses. The Agricultural Outlook magazine, the Agency's monthly comprehensive look at the food and agricultural sector, is prepared in the Section.

Macroeconomic Analysis Section

This section has primary responsibility for conducting research and analyses of macroeconomic activity as it affects the food and agricultural sector. Macroeconomic forecasts are performed for the baseline, monthly update, special studies and situation and outlook activities. Forecasts of macroeconomic variables such as domestic economic growth, unemployment, interest rates, inflation, etc. are developed using a variety of sources. Effects of changes in monetary and fiscal policy are analyzed as they impact the demand and supply for agricultural products, both domestically and in foreign markets. Research is also conducted which examines the performance of the farm sector compared to other sectors of the economy, and interaction between agriculture and other sectors of the economy.

Agricultural Finance Section

Research is conducted on factors affecting financial structure of the farm sector and consequences for production and marketing. The Section staff evaluate factors affecting capital formation in agriculture, how farmers use and acquire debt, and the consequences for farm sector risk, growth, wealth

and rates of return, etc. Analysis of farm financial conditions and outlook are reported in the Agricultural Finance Situation and Outlook Report.

Credit and Tax Policy Section

This section performs research and analyses on factors affecting the supply and demand of funds in agricultural financial markets and on policies affecting the performance of agricultural lending institutions. A major effort is underway to evaluate the consequences of Federal credit programs for the food and agricultural sector. Additional responsibilities include analyzing Federal income and estate tax policies as they affect resource allocation, production and marketing decisions, and the ownership and transfer of agricultural capital.

Modeling Activities in FAA

Models are developed and maintained to augment staff analysis, and situation and outlook activities. Models in use or being developed in the FAA Branch range from annual macroeconomic, multi-sector, fully endogenous models to quarterly sector specific, partial equilibrium models (figure 3). Models are used as a source of information for analysis. The results of more than one model are frequently used. Depending on the complexity of the problem, and the suitability of the model, a good bit of analyst judgement may be used as well.

Aggregate Macro/Agriculture Linkage Model

This model, currently on the drawing board, would be used primarily for short term macroeconomic forecasting and analyzing the impact of macroeconomic developments on aggregate agricultural conditions. It would endogenize the agricultural sector with the domestic and international economy and would be an annual model with perhaps 40 to 60 equations. Rapid turnaround time and minimal maintenance requirements are essential for its use in staff analysis.

FIGURE 3. MODEL ACTIVITIES OF THE FINANCE AND AGGREGATE ANALYSIS BRANCH

1. AGGREGATE MACRO/AGRICULTURAL LINKAGE MODEL
2. QUARTERLY COMMODITY MODEL
3. LONG TERM GENERAL EQUILIBRIUM MODEL
4. MONEY MARKET MODEL
5. DISAGGREGATED FINANCIAL SECTOR MODEL
6. INPUT/OUTPUT MODEL

Quarterly Commodity Model

A short-run quarterly commodity model is needed to support situation and outlook analyses and conduct staff analyses. It would also be used to ensure that outlook analysis for various crop and livestock sectors are internally consistent. Initially this model will cover only major agricultural commodities (wheat, corn, soybeans, beef, pork, and poultry) but perhaps more commodities will be added later. In addition, the model will provide forecasts of farm income and food price indicators that are consistent with commodity supply, demand, and prices. The domestic and international economies will be exogenous to this model. This model must be easy to use and provide rapid turn-around. It will provide an overall check to the situation and outlook process which currently is conducted by macroeconomic, crop and livestock analysts. The linked subsector model will be available and documented in late 1984.

Long Term General Equilibrium Model 1/

ERS has supported the development of the GEM model and subsequent modifications (COMPOL, COMGEM) which improved the specification of commodity policies, commodity markets, and agricultural lending activities. The model fully endogenizes the agricultural sector with the general economy and, in addition to providing commodity statistics, provides farm sector income, balance sheet, and cash sources and uses of funds statements. The model can be useful in evaluating the long term consequences of macroeconomic policy, and other changes on the economic and financial characteristics of the farm sector.

Further research should be directed at improving the trade sector.

^{1/} The General Equilibrium Model (GEM) was developed at Texas A&M University with ERS support. For more details, see Dean W. Hughes and John B. Penson, Jr., Description and Use of a Macroeconomic Model of the U.S. Economy Which Emphasizes Agriculture, Technical Report No. DTR 80-5, Texas Agricultural Experiment Station, Texas A&M University.

Money Market Model

A money market model is needed to analyze the impacts of Federal Reserve activity on forecasts of interest rates. The approach being taken is to model interest rates using a reserve based, money market model which solves for the Federal funds rate that equalizes the supply and demand for bank reserves. Equations of an efficient market type term structure can be used to forecast the Treasury yield curve, prime rate or other money market rates. This model will improve macro forecasts and form the basis of forecasts for specific interest rates facing farmers by such institutions as Production Credit Associations, Federal Land Banks, and agricultural banks.

Work on this model is underway and should be completed by October of 1984.

Input/Output Model

This model enables the Branch to analyze the direct and indirect linkages between the various sectors of the economy and provides the basis for the annual estimates of the employment and gross national product originating in the U.S. food and fiber system. Additional model applications include quantification of farm-nonfarm linkages and impact analysis of exogenous demands and of exogenous price shocks.

Currently, the I/O models are based on the 1972 national economy. The I/O table for the 1977 national economy should be released by the Department of Commerce this year, and the models will be updated to the new base year.

Disaggregated Financial Sector Model

There is a need to model the disaggregated financial sector and agriculture linkage. This linkage is present in the GEM model but in an aggregate form. Agricultural Credit is supplied from several sources: Farm Credit System, 31 percent; commercial banks, 21 percent; Farmers Home Administration, 11 percent; and the remainder by the Commodity Credit Corporation, life insurance

companies, merchants, dealers and others. Each lender operates under different regulations and acquires its loanable funds in ways that are different. Thus, changes in fiscal and monetary policy will affect each lender differently.

A disaggregated model will specify specific demand and supply equations for most of the suppliers of agricultural credit. This model will be incorporated into the COMGEM macroeconomic forecasting model. Since the financial sector is disaggregated, questions can be answered, in part, about the effects of monetary policy changes upon the cost and availability of loan funds at different financial intermediaries. This modeling effort is being performed by ERS at Texas A&M University.

Conclusions

Despite frequent claims to the contrary, no single model can adequately be used to address the broad range of issues that may arise in one particular area. And even if it would, it is preferred to have at one's disposal results from other models that may be based on different assumptions and contain alternative specifications of economic relationships. The additional information resulting from more than one model makes the analysis that much more robust. It is, however, the responsibility of the analyst to thoroughly understand the structure of the model and its implicit assumptions regarding economic/behavioral relationships.

AN OVERVIEW OF THE DEVELOPMENT AND
APPLICABILITY OF THE COMGEM MODEL

BY

JOHN B. PENSON, JR.

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AN OVERVIEW OF THE DEVELOPMENT AND APPLICABILITY OF THE COMGEM MODEL

John B. Penson, Jr.

We certainly have not suffered from a shortage of econometric models focusing on aggregate outcomes in agriculture. Some of these econometric modeling efforts have focused their attention on a particular market or commodity (e.g., eggs, milk, soybeans, etc.). Other econometric studies have focused their attention on the sector as a whole. For example, Karl Fox estimated "A Submodel of the Agricultural Sector" that was incorporated into the Brookings quarterly econometric model of the U.S. economy back in the early sixties. Tyner and Tweeten a few years later developed one of the first econometric models designed to evaluate the effects of alternative farm program policies. These studies in many ways represent the antecedents to much of today's econometric modeling efforts. One has to be impressed with the number of econometric models developed since the mid-sixties which focus either all or part of their attention on agriculture.

The purpose of this paper is to provide an overview of one such modeling effort; namely, the Commodity Specific General Equilibrium Model, or COMGEM. The first section of this paper addresses the general issue of why have an econometric model at all and, given a successful resolution of this issue, why do we need COMGEM given the number of existing models alluded to above. This discussion spells out our specific reasons for developing COMGEM. The next section of this paper provides an overview of the procedures followed in the model's development that have led us to where we are today. This discussion addresses the size and scope of COMGEM, the nature

of the programming efforts required in the estimation and simulation stages, and the manner in which these efforts were accomplished. The papers presented by Hughes and Romain will go into considerably more detail on the general properties of specific components of COMGEM. Included in their papers is an indication of how specific monetary, fiscal and farm program policies are reflected in this model. This section will also discuss the general nature of the exogenous variables in COMGEM which the user must specify before simulation. The third section of this paper describes the output of the model once it has been solved, including the various commodity reports and financial statements it generates. The final section of this paper will focus on the general applicability of the model to policy issues.

Why Did We Develop COMGEM?

In answering the question raised by the title of this section, let us discuss the need for econometric models in general before addressing the need for COMGEM in particular.

Need for an econometric model

Econometric models of the size and scope discussed in this workshop require considerable financial and professional resources long before the model is first used. The immediate question that no doubt comes to mind for many individuals is "Are they worth it?" McNees of the Boston Federal Reserve Bank has gained a great deal of notariety in recent years by tracking the performance of the major macroeconomic models and comparing their

forecasting performance with judgemental forecasts. He finds that such models on average do no better or no worse than judgemental forecasts. Rausser and Just also recently indicated that forecasts of commodity prices by econometric models were on average no more accurate than the prices indicated by the futures market.

If this is true, then why has the U.S. Department of Agriculture, for example, committed so many dollars to the development of econometric models which focus on aggregate outcomes in agriculture?¹ The value of a large-scale econometric model does not rest entirely upon its use as a forecasting device. Sure, it would be nice if econometric models provided error-free point forecasts of prices, interest rates, output, etc. But even if they do no better than judgemental forecasts, such as those given by the USDA's "delphi" procedure for forecasting a set of "Ps" and "Qs", econometric models have other attributes that may well make them "worth the effort".

Econometric models provide a means by which we can vary assumptions about a set of exogenous forces and quickly determine in a *systematic fashion* what these assumptions mean for those endogenous variables of interest to policymakers and others. If you have ever awaited the results of a delphi forecast of supply response and cash receipts, you know this process can take weeks, perhaps even months. During this time period, events may cause

¹ The U.S. Department of Agriculture has been an active supporter of such research, both in terms of providing necessary for econometric analysis and in providing the manhours and/or dollars needed to develop econometric models. In fact, the model discussed in this paper and the papers Hughes and Romain today probably would not have been built if it were not for the financial and technical support provided by ERS-USDA.

one to change the nature of the assumptions made when requesting the forecast. Futures markets have the limitation of forecasting only a portion of the variables desired by policymakers. An econometric model equipped to address the issue in question can provide a complete forecast in a matter of minutes and do it repetitively if a parametric variation of the set of assumptions is desired. Thus, econometric models have value in policy analysis in that they facilitate the study of departures from a baseline forecast associated with alternative sets of assumptions. When combined with the judgement of the model's builders and others, econometric models represent a valuable tool in policy analysis.

Need for COMGEM

Having hopefully clarified the need for econometric models as a means of systematically examining alternative policies or exogenous forces for their effect on agriculture, let us now turn to why we felt yet another econometric model for agriculture was needed. Early econometric efforts to model aggregate outcomes in agriculture can be characterized as "stand alone" models.² Disturbances originating in agriculture in such models are assumed to have no feedback effects on the rest of the economy over the length of the forecast horizon. Annual or quarterly values of such exogenous variables as consumer disposable income, interest rates and general price movements are generally prescribed over this time period and are assumed to remain constant no matter what happens in agriculture. An exam-

² The discussion of models in the remainder of this paper will be limited to those models which - at minimum - forecast the value of gross and net farm income. This therefore automatically omits market equilibrium models for particular commodities.

ple of this type of model is the Tyner-Tweeten model mentioned earlier. These models generally omit many of the transmission mechanisms through which events in other sectors of the macroeconomy are relayed to agriculture.

A second category of econometric modeling efforts in agriculture includes those models which allow for a *recursive feedback* of events in agriculture to other sectors. As the major "profit seeking" macroeconomic models of the economy began to discover the presence of an agricultural sector in our economy, we began to see more models of this type. Such models represent a definite improvement over the "stand alone" models in that they facilitate a more comprehensive examination of the effects that macroeconomic policies have upon agriculture over time. Johnson, however, has criticized models capturing the interface between agriculture and the rest of the economy by recursively linking agricultural sector modeling efforts to an established macroeconomic model. He concluded that "there must be more to the connection between economic sectors of the economy" (p.134).

Both categories of econometric models identified above tend for one reason or another to concentrate their modeling efforts on the income and expense flows in agriculture. Capital expenditures and the flow of loan funds are generally not modeled. This, of course, brings into question how depreciation and interest expenses were determined when forecasting net farm income. It also underscores the fact that several important transmission mechanisms through which national economic policies can influence the growth of farm output over time are also ignored.

The modeling efforts at Texas A&M University in cooperation with the U.S. Department of Agriculture which have led to the development of COMGEM were in response to calls in the literature for greater endogenization of the linkages between agriculture and the rest of the economy. Just suggested that the interface between agriculture and the general economy includes at least three forms of interaction: (1) the interaction of the general price and income levels, agricultural marketing costs and raw agricultural product prices in the domestic demand for raw agricultural products, (2) the interaction of agricultural input markets - which are influenced by other sectors - with the supply side of raw agricultural products and (3) the interaction of international trade and nonagricultural products in determining trade balances, exchange rates and export demand. As Just pointed out, both the "stand alone" and "recursive" forms of econometric models discussed above have placed primary emphasis on the first form of interaction and little or no emphasis on the other two. Penson and Hughes later added to Just's list of interactions by acknowledging the interaction between the bond and equity capital markets, financial intermediaries and the cost and availability of loan funds to finance farm business operating expenses and capital expenditures.

These various forms of interaction taken together suggest that agriculture is a highly integrated partner in the domestic and world economies and that efforts to model events in agriculture should account for any simultaneities inherent in these interrelationships.

The Development of COMGEM

COMGEM is designed to capture the feedback relationships between agriculture and the rest of the macroeconomy in a *fully simultaneous* fashion. As you can well imagine, this required a substantial commitment of manhours and dollars to complete. Let me take a few moments to give you some insights to (1) the scope of the model, (2) the size of the model, (3) the stages in the model's development and (4) the nature of the exogenous variables the user must specify when projecting beyond the sample period.

Scope of the model

Explicitly captured in this multi-sector macroeconomic model are the interactions between (1) agriculture and the suppliers of manufactured production inputs, (2) agricultural output, wholesale purchases of food items, and the final consumption of agricultural goods at the retail level, (3) agriculture and the U.S. balance of trade and exchange rates, (4) agriculture and the government sector and (5) agriculture and the nation's financial markets. As Hughes will discuss in more detail in his paper, the model contains several groups of economic transactors or sectors, including farm operator families, other domestic consumers, nonfarm businesses, governments and financial intermediaries as well as a "rest-of-the-world" sector. Goods and services transacted between these sectors take place in a set of markets which are solved for simultaneously to determine a set of general equilibrium prices and quantities.

Size of the model

The multi-sector nature of COMGEM means, of course, that we must have more than one production function, more than one consumption function, more than one investment function, etc. It should come as no surprise therefore that COMGEM easily qualifies for consideration as a "large scale" econometric model. There are currently 321 endogenous variables in COMGEM. The data bank used to support this modeling effort contains times series data on almost 700 variables covering the 1950-1980 period.

Programming of the model

All the equations in COMGEM were estimated and then solved in constant dollars. Several simultaneous equations estimators such as the Structurally-Oriented Instrumental Variables (SOIV) and the Iterative Instrumental Variables (IIV) estimators were used in the initial phases of the estimating the model. The ordinary least squares (OLS) estimator, however, was found to perform as well as the SOIV and IIV estimators, and therefore was used to estimate all the coefficients in COMGEM. One obvious benefit associated with adopting the OLS estimator in a large model like COMGEM is that we do not have to reestimate the entire model when changing the specification of say one equation.

Once the estimation stage was completed, the estimated equations, ancillary definitions, etc. were incorporated into the Gauss-Siedel algorithm in the General Analytical Simulation Solution Package (GASSP) written by Kite and others at the U.S. Department of Agriculture. This algorithm is specifically designed to solve systems of nonlinear simultaneous equations.

Additional subroutines had to be added to GASSP to meet our specific informational needs. One example is the subroutine which prepares the user-oriented reports which are reported in current dollars. These reports will be discussed in the next section of this paper.

The task of programming the estimation and simulation stages of this project was monumental in scope as both Hughes and Romain can attest to far better than I can. Actually, this programming effort was carried out in two phases, commonly referred to by some as Ph. D theses. Hughes initially developed the multi-sector general equilibrium structure that underlies COMGEM. Hughes initial work was one of the first models capable of examining the long run effects of monetary and fiscal policy on the economic growth and financial structure of agriculture in a fully simultaneous fashion with the rest of the macroeconomy. There were no provisions made, however, for the commodity detail needed to examine farm program policy alternatives. Romain later addressed this need by disaggregating the supply response and market outcomes for raw agricultural products in the model. More specifically, Romain expanded the model to individually account for the output, prices received and quantities marketed for such major crops as corn, soybeans, wheat, oats, barley, sorghum and cotton. He also disaggregated the livestock and livestock products component of the model to specifically account for cattle and calves, hogs and milk. This modeling effort was carried out in such a fashion that past and current farm program policies can be examined for their effect on the sector's economic performance and financial position. Both programming efforts together form the specification of COMGEM discussed in this paper as well as the papers presented by Hughes and Romain.

Nature of exogenous variables

Approximately 40 percent of the 129 exogenous variables that the user must supply information for beyond the sample period can be categorized as policy-related variables. These variables include information pertaining to the price supports, diversion payments, release prices, minimum acceptable government stocks and other features of the commodity programs for the seven major crops individually modeled in COMGEM. Also captured here are the policy variables related to the milk program. In addition to these farm program policy variables, monetary and fiscal policy variables such as the fractional reserve requirement ratios for demand deposits and time deposits, the discount rate, the investment tax credit rate and the maximum corporate tax rate are captured in this group of exogenous variables.

An additional 17 percent of the exogenous variables the user must supply information on pertain to the levels of imports and exports for specific crops and livestock products. Another 20 percent reflect the weights used in calculating specific indices for the prices received and prices paid by farmers as well as the consumer price index reported for the user's information. The remaining 23 percent of these exogenous variables pertain to either (1) events in the domestic and foreign economies not specifically modeled in COMGEM or (2) a limited number of dummy variables (six) initially included in the estimated equations to reflect specific events which took place during the sample period. Examples of those events in the domestic and foreign economies not specifically modeled in COMGEM are the U.S. population, the population in the rest of the world, the budget deficit and the government bonds held in the private sectors. The nature and role of

the policy-related exogenous variables will be discussed in the papers by Hughes and Romain.

Reports Supplied by COMGEM

The GASSP package used to simulate COMGEM prepares a report of the solution values for all the endogenous variables. The solution values for these variables are reported in constant dollars since the model is solved in constant dollars. To provide the user of COMGEM with a set of readily-usable reports, a report writer was programmed. This report writer provides the following reports to the user in current dollars: (1) a summary of selected macroeconomic variables, (2) a commodity summary for each of the crops, livestock and livestock products individually modeled in COMGEM, (3) a balance sheet for each of the economic sectors delineated in COMGEM, (4) a listing of the prices received, prices paid and interest rates relevant to farmers, (5) a report of cash receipts by commodity, (6) a detailed income statement and (7) a sources and uses of funds statement. Let us focus on several of these reports to give you an insight to the nature of the information provided to the user of this model. The information contained in the specific reports discussed in this section reflect the historical data observed during the 1976-1980 period.

Macroeconomic variables

The summary report of macroeconomic variables provided by COMGEM is illustrated in Table 1. This report tells the user what is happening to gross national product in both current and constant dollars. It also reports the implicit GNP price deflator as well as the CPI and its compo-

COMGEM REPORT OF HISTORICAL DATA FOR THE 1976-1980 PERIOD:

TABLE 1 - REPORT OF SELECTED MACROECONOMIC VARIABLES

ITEMS	1976	1977	1978	1979	1980
GROSS NATIONAL PRODUCT (GNP)					
NOMINAL U.S. GNP	1718.0	1918.0	2156.1	2413.9	2626.1
PERCENT CHANGE	10.9	11.6	12.4	12.0	8.8
CONSTANT DOLLAR GNP	1028.1	1084.4	1136.0	1172.5	1170.6
PERCENT CHANGE	5.4	5.5	4.8	3.2	-0.2
PRICES.					
GNP DEFLATOR	167.1	176.9	189.8	205.9	224.3
PERCENT CHANGE	5.2	5.8	7.3	8.5	9.0
CONSUMER PRICE INDEX (CPI)	170.5	181.5	195.4	217.4	246.8
PERCENT CHANGE	5.8	6.5	7.7	11.3	13.5
CPI FOOD	180.8	192.2	211.4	234.5	254.6
PERCENT CHANGE	3.1	6.3	10.0	10.9	8.6
CPI DURABLES	154.3	163.2	173.9	191.1	210.4
PERCENT CHANGE	6.0	5.8	6.6	9.9	10.1
CPI NONFOOD NONDURABLES	171.9	183.8	199.5	223.4	259.3
PERCENT CHANGE	6.9	6.9	8.6	12.0	16.0
INTEREST RATES:					
NOMINAL RATE ON 3 MONTH TREASURY BILLS	5.0	5.3	7.2	10.1	11.4
REAL RATE ON 3 MONTH TREASURY BILLS	-0.2	-0.6	-0.1	1.6	2.5
NOMINAL RATE ON 3/5 YEAR GOVERNMENT BONDS	7.2	7.0	8.3	9.5	11.5
REAL RATE ON 3/5 YEAR GOVERNMENT BONDS	2.0	1.1	1.0	1.0	2.5
NOMINAL RATE ON LONG TERM GOVERNMENT BONDS	7.9	7.7	8.5	9.3	11.4
REAL RATE ON LONG TERM GOVERNMENT BONDS	2.6	1.8	1.2	0.9	2.4
NOMINAL PRIME INTEREST RATE	6.8	6.8	9.0	12.7	15.3
REAL PRIME INTEREST RATE	1.6	1.0	1.7	4.2	6.3
NOMINAL RATE ON COMMERCIAL BONDS	9.0	8.4	9.1	10.1	12.7
REAL RATE ON COMMERCIAL BONDS	3.8	2.6	1.8	1.6	3.8
OTHER VARIABLES (CURRENT DOLLARS):					
BALANCE OF TRADE	9.4	-9.5	-9.0	7.0	10.8
CORPORATE PROFITS	104.9	115.1	132.5	154.2	145.2
DISPOSABLE PERSONAL INCOME	1194.4	1311.5	1462.9	1641.7	1821.7
CONSUMPTION BY:					
FARM OPERATOR FAMILIES	53.8	49.3	60.5	71.9	62.4
OTHER DOMESTIC CONSUMERS	1034.2	1159.0	1291.4	1442.8	1611.2
INCOME TAXES PAID BY:					
FARM OPERATOR FAMILIES	4.7	4.9	6.7	8.2	7.0
OTHER DOMESTIC CONSUMERS	467.5	525.4	589.4	666.7	744.7
NONFARM BUSINESSES	63.8	72.6	83.0	87.6	82.3
BUDGET DEFICIT	53.1	46.4	29.2	14.8	61.2
CHANGE IN STOCK OF GOVERNMENT BONDS	60.1	51.8	47.3	31.9	75.9

VALUES EXPRESSED IN BILLIONS OF DOLLARS OR PERCENTAGES.

nents. Interest rates on various maturities of government securities and other interest rates are reported here in both real and nominal terms. A final group of macroeconomic variables reported in current dollars include the balance of trade, disposable personal income, consumption, taxes, the budget deficit and the change in the stock of privately held government bonds.

Summary reports for crops

There are seven reports supplied by COMGEM which provide selected summary statistics for each of the major commodities individually modeled. Table 2 presents the summary report for wheat. Included in this report is information on acres planted, acres harvested, yield per acre and total domestic production. Also included is information on imports, exports, year-end stocks and several marketing year prices. The bottom line in each of these commodity reports is the cash receipts received by farmers for the crop during the calendar year.

Summary reports for livestock

Tables 3, 4 and 5 present the summary reports for cattle and calves, hogs and milk. The report for cattle and calves captures the breeding stock for both dairy cattle and beef cattle. The total production of veal and beef, the prices received for these products and total cash receipts for cattle and calves are also presented in this table. Table 4 reports much the same information for hogs. Finally, Table 5 presents the summary report for milk. Included in this table is an accounting of the total production of milk and its disappearance, the prices for specific categories of milk

CUMGEM REPORT OF HISTORICAL DATA FOR THE 1976-1980 PERIOD:

TABLE 2 - SUMMARY REPORT FOR WHEAT

ITEMS	1976	1977	1978	1979	1980
TOTAL ACREAGE (MILLIONS)					
ACREAGE PLANTED	80.4	75.4	66.0	71.4	80.4
ACREAGE HARVESTED	70.9	66.7	56.5	62.5	70.9
YIELD (BU./ACRE)	30.3	30.7	31.4	34.2	33.4
TOTAL PRODUCTION (MIL. BU.)	2148.8	2045.5	1775.5	2134.1	2369.7
IMPORTS (MIL. BU.)	2.0	2.0	2.0	2.0	3.0
EXPORTS (MIL. BU.)	950.0	1124.0	1194.0	1375.0	1510.0
MARKETING YEAR ENDING STOCKS (MIL. BU.)					
ENDING PRIVATE STOCK (MIL. BU.)	734.9	528.1	348.2	355.0	375.1
ENDING GOV. STOCK (MIL. BU.)	378.3	649.7	575.9	547.0	613.9
TOTAL ENDING STOCK (MIL. BU.)	1113.2	1177.8	924.1	902.0	989.0
MARKETING YEAR PRICES (\$/BU.)					
LOAN RATE	2.25	2.25	2.35	2.50	3.30
RELEASE PRICE	2.59	3.15	3.29	3.75	4.20
EXPECTED FARM PRICE	4.80	3.00	2.75	2.76	3.94
AVERAGE MARKET PRICE	2.73	2.33	2.97	3.78	4.15
CASH RECEIPTS (CALENDAR YEAR; BIL. \$)	5.84	5.08	4.69	7.82	9.00

CUMGEM REPORT OF HISTORICAL DATA FOR THE 1976-1980 PERIOD

TABLE 3 - SUMMARY REPORT FOR CATTLE AND CALVES

ITEMS	1976	1977	1978	1979	1980
BREEDING STOCK OF CATTLE (1000 HD)					
DAIRY CATTLE	10998.0	10896.0	10790.0	10779.0	10869.0
BEEF CATTLE	41443.0	38738.0	37062.0	37086.0	38987.0
TOTAL	52441.0	49634.0	47852.0	47865.0	49856.0
VEAL (MIL. LB)					
TOTAL PRODUCTION	853.0	834.0	632.0	434.0	400.0
NET IMPORT	10.0	10.0	18.0	19.0	18.0
U.S. CONSUMPTION	863.0	844.0	652.0	452.0	419.0
PER CAPITA (LB)	4.0	3.8	2.9	2.0	1.8
ENDING STOCK (PROCESSED MEAT)	11.0	11.0	9.0	10.0	9.0
BEEF (MIL. LB)					
TOTAL PRODUCTION	25969.0	25279.0	24242.0	21446.0	21644.0
NET IMPORT	1915.0	1772.0	2083.0	2190.0	1844.0
U.S. CONSUMPTION	27780.0	27189.0	26236.0	23691.0	23510.0
PER CAPITA (LB)	127.7	123.7	118.1	105.5	103.5
ENDING STOCK (PROCESSED MEAT)	454.0	316.0	405.0	350.0	328.0
PRICES					
FARM PRICE OF VEAL (\$/CWT)	34.10	36.90	59.10	88.70	76.80
PERCENT CHANGE	25.37	8.21	60.16	50.08	-13.42
FARM PRICE OF BEEF (\$/CWT)	33.70	34.40	48.50	66.10	62.40
PERCENT CHANGE	4.66	2.08	40.99	36.29	-5.60
RETAIL PRICE INDEX OF VEAL (1967=1.0)	1.84	1.86	2.22	3.00	3.29
PERCENT CHANGE	-4.31	1.15	19.51	34.75	9.64
RETAIL PRICE INDEX OF BEEF (1967=1.0)	1.64	1.63	2.00	2.55	2.69
PERCENT CHANGE	-3.15	-0.61	23.06	27.18	5.61
CASH RECEIPTS (CATTLE AND CALVES; BIL. \$)	19.80	20.38	28.50	34.86	31.58

COMGEM REPORT OF HISTORICAL DATA FOR THE 1976-1980 PERIOD:

TABLE 4 - SUMMARY REPORT FOR HOGS

ITEMS	1976	1977	1978	1979	1980
BREEDING STOCK OF HOG (1000 HD)	8011.0	8604.0	9605.0	9655.0	9149.0
PORK (MIL. LB)					
TOTAL PRODUCTION	12688.0	13247.0	13393.0	15450.0	16615.0
NET IMPORTS	48.0	40.0	74.0	51.0	133.0
U.S. CONSUMPTION	12773.0	13313.0	13411.0	15462.0	16680.0
PER CAPITA (LB)	58.7	60.6	60.4	68.8	73.4
ENDING STOCK (PROCESSED MEAT)	212.0	186.0	242.0	281.0	349.0
PRICES					
FARM PRICE OF HOG (\$/CWT)	43.30	39.40	46.60	41.80	38.00
PERCENT CHANGE	-6.07	-9.01	18.27	-10.30	-9.09
RETAIL PRICE INDEX OF PORK (1967=1.0)	2.00	1.89	2.13	2.16	2.09
PERCENT CHANGE	1.32	-5.36	12.87	1.55	-3.37
CASH RECEIPTS (BIL. \$)	7.53	7.55	9.04	9.30	9.14

COMGEM REPORT OF HISTORICAL DATA FOR THE 1976-1980 PERIOD.

TABLE 5 - SUMMARY REPORT FOR MILK

ITEMS	1976	1977	1978	1979	1980
STOCK OF DAIRY CATTLE (1000 HD)	10998.0	10896.0	10790.0	10779.0	10869.0
TOTAL MILK PRODUCTION (MIL. LB)	120180.0	122654.0	121461.0	123411.0	128425.0
PER COW (LB)	10891.3	11204.4	11201.8	11443.4	11864.8
MILK DISAPPEARANCE (MIL. LB)					
FARM CONSUMPTION	2959.0	2824.0	2665.0	2468.0	2339.0
CONS. OF FLUID MILK	51502.0	51380.0	51175.0	51386.0	50933.0
CONS. OF MAN. MILK	64291.0	63523.0	66575.0	68662.0	67741.0
NET IMPORTS	916.0	976.0	1332.0	1285.0	583.0
ENDING PRIVATE STOCK	5299.0	4916.0	4475.0	5419.0	5752.0
ENDING GOV. STOCK	410.0	3710.0	4254.0	3180.0	7207.0
PRICES					
FARM PRICE FLUID MILK (\$/CWT)	11.13	11.13	11.90	13.26	14.52
PERCENT CHANGE	9.54	0.07	6.91	11.40	9.50
FARM PRICE MAN. MILK (\$/CWT)	8.56	8.70	9.65	11.10	12.00
PERCENT CHANGE	12.19	1.64	10.92	15.03	8.11
FARM PRICE ALL MILK (\$/CWT)	9.66	9.72	10.60	12.00	13.00
PERCENT CHANGE	10.40	0.62	9.05	13.21	8.33
EXPECTED PRICE BY FARMERS (\$/CWT)	9.89	10.21	11.02	12.78	14.05
PERCENT CHANGE	6.01	3.20	7.98	15.97	9.89
SUPPORT PRICE ON DEC. 31	8.26	9.00	9.87	11.49	13.10
PERCENT CHANGE	7.13	8.96	9.67	16.41	14.01
RETAIL PRICE INDEX OF FLUID MILK (1967=1.0)	1.76	1.82	1.95	2.18	2.40
PERCENT CHANGE	10.16	3.77	7.15	11.49	10.28
RETAIL PRICE INDEX OF MAN. MILK (1967=1.0)	1.61	1.62	1.72	1.91	2.08
PERCENT CHANGE	5.24	1.00	5.79	11.53	8.83
CASH RECEIPTS (BIL. \$)	11.57	11.88	12.82	14.79	16.72

and the cash receipts received by dairy farmers during the year.

Balance sheet

Table 6 presents the balance sheet of the farm sector which is much like the one published in *Economic Indicators of the Farm Sector* by the U.S. Department of Agriculture. Assets are grouped according to whether they are physical or financial in nature. Both physical assets and liabilities are further disaggregated along real estate and non-real estate lines.

Income statement

Tables 7 and 8 constitute the reports generated by COMGEM that pertain to the income received by farmers from farm sources. Table 7 presents a breakdown of the total farm cash receipts received by farmers during the calendar year. This same information is repeated in a more aggregate form at the top of the income statement presented in Table 8. This latter table also reports the farmers' other sources of farm income included in total gross farm income as well as selected components of total farm production expenses. The bottom line in this table represents net farm income in current dollars.

Applicability of COMGEM

If COMGEM has a comparative advantage over other econometric models which focus all or part of their attention on agriculture, it is in its ability to examine the *long run effects* of policy alternatives or exogenous forces. This observation is based on the fact that: (1) COMGEM models the interface between agriculture and the rest of the economy in a fully simul-

COMGEM REPORT OF HISTORICAL DATA FOR THE 1976-1980 PERIOD

TABLE 6 - BALANCE SHEET OF THE FARMING SECTOR

ITEMS	1976	1977	1978	1979	1980
ASSETS					
PHYSICAL ASSETS:					
REAL ESTATE	496.4	554.7	655.0	755.9	830.0
NONREAL ESTATE:					
LIVESTOCK AND POULTRY	29.0	31.9	51.3	61.4	60.9
MACHINERY AND MOTOR VEHICLES	71.0	76.9	85.1	96.7	102.3
CROPS STORED ON AND OFF FARMS	22.1	24.8	28.0	33.5	36.4
HOUSEHOLD EQUIPMENT AND FURNISHINGS	13.7	15.5	18.0	19.4	22.0
FINANCIAL ASSETS:					
DEPOSITS AND CURRENCY	14.9	15.4	15.5	15.9	16.2
U.S. SAVINGS BONDS AND INVST. IN COOPS	17.0	18.2	19.9	21.3	23.8
TOTAL	664.1	737.4	872.8	1004.0	1091.6
CLAIMS					
LIABILITIES:					
REAL ESTATE DEBT	56.5	63.7	70.8	82.7	92.0
NONREAL ESTATE DEBT	46.1	55.6	65.3	75.2	82.6
TOTAL LIABILITIES	102.6	119.3	136.1	157.9	174.6
PROPRIETORS EQUITIES	561.5	618.1	736.7	846.1	917.0
TOTAL	664.1	737.4	872.8	1004.0	1091.6

VALUES EXPRESSED IN BILLIONS OF CURRENT DOLLARS.

COMGEM REPORT OF HISTORICAL DATA FOR THE 1976-1980 PERIOD:

TABLE 7 - SUMMARY OF FARM CASH RECEIPTS

ITEMS	1976	1977	1978	1979	1980
INCOME					
CASH RECEIPTS FROM CROPS:					
WHEAT	5.84	5.08	4.69	7.82	9.00
CORN	9.42	8.63	8.25	10.28	12.87
OATS	0.34	0.31	0.28	0.27	0.25
BARLEY	0.65	0.55	0.61	0.65	0.68
SORGHUM	1.16	0.98	0.90	1.15	1.12
COTTON	3.48	3.47	3.47	4.31	4.48
SOYBEANS	8.62	8.69	11.82	12.98	13.37
OTHER CROPS	19.17	20.94	23.70	25.94	27.26
TOTAL	48.67	48.65	53.71	63.39	69.03
CASH RECEIPTS FROM LIVESTOCK:					
CATTLE AND CALVES	19.80	20.38	28.50	34.86	31.58
HOGS	7.53	7.55	9.04	9.30	9.14
MILK	11.57	11.88	12.82	14.79	16.72
OTHER LIVESTOCK	7.22	7.83	8.85	9.58	9.96
TOTAL	46.11	47.64	59.21	68.52	67.40
GOVERNMENT PAYMENTS	0.7	1.8	3.0	1.4	1.3
TOTAL CASH RECEIPTS	95.5	98.1	116.0	133.3	137.7

VALUES EXPRESSED IN BILLIONS OF CURRENT DOLLARS

COMGEM REPORT OF HISTORICAL DATA FOR THE 1976-1980 PERIOD:

TABLE 8 - FARM INCOME STATEMENT

ITEMS	1976	1977	1978	1979	1980
INCOME					
CASH RECEIPTS FROM CROPS:					
CROP MARKETINGS	48.7	48.6	53.7	63.4	69.0
LIVESTOCK MARKETINGS	46.1	47.6	59.2	68.5	67.4
TOTAL	94.8	96.3	112.9	131.9	136.4
GOVERNMENT PAYMENTS	0.7	1.8	3.0	1.4	1.3
TOTAL CASH RECEIPTS	95.5	98.1	116.0	133.3	137.7
NONMONEY AND OTHER FARM INCOME					
FARM CONSUMPTION OF:					
LIVESTOCK	0.9	0.6	0.7	0.9	0.8
CROPS	0.4	0.4	0.4	0.4	0.4
GROSS RENTAL VALUE OF FARM DWELLINGS	6.0	7.1	8.2	9.9	11.4
OTHER FARM INCOME	1.4	1.6	1.7	2.1	2.2
TOTAL REALIZED INCOME	8.7	9.6	11.0	13.3	14.8
NET CHANGE IN FARM INVENTORIES	-2.4	1.0	0.6	5.3	-2.0
TOTAL NONMONEY AND OTHER FARM INCOME	6.3	10.6	11.6	18.6	12.8
TOTAL GROSS FARM INCOME	101.8	108.7	127.5	151.9	150.5
CURRENT FARM OPERATING EXPENSES:					
FEED PURCHASED	14.4	14.0	14.5	17.8	18.6
LIVESTOCK PURCHASED	5.9	7.0	10.1	12.7	10.5
SEED PURCHASED	2.4	2.5	3.6	3.0	3.4
PESTICIDES, FERTILIZER, AND LIME PURCHASED	8.6	8.5	9.3	10.6	13.2
REPAIRS AND OPERATION OF CAPITAL ITEMS					
FARM OPERATOR DWELLINGS	0.3	0.3	0.4	0.4	0.5
SERVICE BUILDINGS	1.0	1.2	1.2	1.3	1.3
MOTOR VEHICLES AND MACHINERY	3.9	4.2	5.0	5.7	6.3
PETROLEUM FUEL AND OIL	4.0	4.4	4.6	6.3	8.1
TOTAL	9.1	10.1	11.2	13.7	16.2
HIRED LABOR					
FARM RESIDENT WORKERS	1.7	2.3	2.0	1.9	1.7
OTHER HIRED WORKERS	5.4	5.5	6.1	7.3	8.6
INTEREST ON NONREAL ESTATE DEBT	3.2	4.0	4.9	6.6	8.5
TOTAL	50.5	53.9	61.7	73.5	80.8
DEPRECIATION AND DAMAGE	13.5	15.0	16.9	19.3	21.4
TAXES ON FARM PROPERTIES	3.6	3.9	3.6	3.8	4.1
INTEREST ON FARM MORTGAGE DEBT	3.9	4.4	5.1	6.1	7.3
NET RENT TO NONOPERATOR LANDLORDS	4.2	4.1	4.9	5.4	5.8
OTHER EXPENSES	7.5	9.1	8.8	11.0	11.3
TOTAL PRODUCTION EXPENSES	83.1	90.3	101.1	119.2	130.7
TOTAL NET FARM INCOME	18.7	18.4	26.5	32.7	19.9

VALUES EXPRESSED IN BILLIONS OF CURRENT DOLLARS.

taneous fashion and (2) COMGEM explicitly accounts for changes in the sector's balance sheet (e.g., land, livestock, machinery, debt outstanding, etc.) which affect its capacity to produce as well as its economic performance and financial position. Those econometric models which are either "recursive" or "stand alone" in design and model only those accounts which appear in the sector's income statement cannot possibly do an adequate job of making long run projections under different policy alternatives.

COMGEM is also well-suited to examine both the direct *and* indirect effects of changes in monetary, fiscal and farm program policy on agriculture. For example, the model has been used in the past to assess such diverse issues as the effects of tax cuts on agriculture and a freeze placed on milk program benefits. We are currently using the model to assess the costs and benefits of the PIK program. In short, early attention to the transmission mechanisms for national economic and farm program policy make COMGEM well-suited for use in aggregate policy analyses.

Summary

The development of COMGEM has been slower than some might wished. However, this modeling effort is not a "one night stand" as Heady quite correctly characterized many academic modeling efforts. We hope you will be hearing alot about COMGEM over the next several years as we have numerous journal papers on the drawing boards and a few technical reports underway. Our continued cooperation with the U.S. Department of Agriculture will see the model increasingly involved in baseline development and policy analysis. COMGEM also represents the centerpiece for aggregate analysis in the newly-created Agricultural Policy Center at Texas A&M University.

Econometric models can play a valuable role in projecting future events or examining the effects of past policies. We think it is a healthy sign that so many institutions - be they academic, governmental or commercial - are active in the econometric modeling of agriculture. And we are bullish about the role COMGEM can play in these efforts.

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THE THEORETICAL MACROECONOMIC STRUCTURE OF
THE COMGEM MODEL

BY
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THE THEORETICAL MACROECONOMIC STRUCTURE OF THE COMGEM MODEL

Dean W. Hughes

The purpose of this paper is to present the structure underlying the macroeconomic components of COMGEM, a commodity-specific general equilibrium model which places particular emphasis on the farm sector of the U.S. economy. This presentation will be made in four parts. First, a standard textbook macroeconomic model will be modified to provide three highly aggregated equations which form the basis of COMGEM. The second section describes the disaggregations required to develop the product markets included in COMGEM. The third section shows how financial markets are disaggregated. The final section describes the linkages between the domestic economy and foreign economies as currently specified in this model.

The approach taken in this presentation differs significantly from previous documentation of our macroeconomic modeling efforts. In a 1980 technical report by Hughes and Penson, the structure of the GEM model - the predecessor to COMGEM - was developed from the micro to the macro. This approach turned out to be confusing, but was not wrong. The approach taken in this presentation is to move from the macro to the micro. Hopefully this approach will be enlightening to a broader audience since it begins with a widely known theoretical macroeconomic structure before discussing the sector level disaggregations found in the model.

Adapting A Textbook Macroeconomic Model

The behavioral equations in a standard textbook macroeconomic model

generally include equilibriums for the product markets (the IS curve), the money market (the LM curve) and the labor market (the aggregate supply or AS curve). Such a model can be stated in mathematical terms as follows:¹

$$(1) \quad Y/P = c(Y/P, r, W/P) + i(Y/P, r) + g \quad (\text{the IS curve})$$

$$(2) \quad M/P = l(Y/P, r, W/P) \quad (\text{the LM curve})$$

$$(3) \quad P^\circ = P^{\circ e} + a(Y - Y_p)/Y_p \quad (\text{the AS curve})$$

where Y represents nominal gross national income; P is a measure of the overall price level (i.e., the numeraire); r is a real interest rate; W is the nominal value of wealth, which includes the capital stock (K), money (M) and government bonds (B); c represents real consumption expenditures; i represents real investment expenditures; g is real government expenditures; P° is the rate of change in the general price level; $P^{\circ e}$ is the expected rate of change in the general price level and Y_p represents potential output.

This section describes the adjustments made to this simple textbook macroeconomic model before the model is disaggregated to capture the detail of the farm sector and its linkages to the rest of the economy. These adjustments include a respecification of the LM curve to improve the dynamic behavior of the model as well as a restatement of the AS curve to allow for its estimation.

¹ Some of the simplifying assumptions reflected in these equations are not reflected in COMGEM. For example, the model captures the tax rate effects on consumption and investment expenditures, and money is not assumed to be neutral in the short run. These simplifying assumptions were made here to facilitate the presentation.

Replacing the LM curve

At first glance, there appear to be three endogenous variables (i.e., Y/P , r and P^o) in this three-equation model. There are, however, five variables imbedded in this simple model (the three above plus the quantity and interest rate on government bonds). To define wealth, government bonds must be included. However, equations detailing the demand for and supply of these bonds are omitted in most standard textbook models. Instead, most authors implicitly use Walras Law and the government budget constraint to remove references to both the quantity and price (or interest rate) of government bonds.

A simplistic statement of Walras Law would be that every dollar of income is used in some way. Thus, dollars not spent on consumption or taxes (savings) are used to increase wealth. This statement can be expressed algebraically as follows:²

$$(4) \quad S = \Delta W = \Delta M + \Delta B + I \quad (\text{Walras Law})$$

where S represents savings, ΔW is the change in wealth, ΔM is the change in base money, B is the change in the value of government bonds owned by the public and I represents nominal gross investment.³ Through algebraic manipulation, equation (4) can be solved to give the residual demand for bonds as

² The following analysis on the adaptations of the standard textbook model is done in nominal terms to simplify the notation. All terms could equivalently be divided by P to represent them in real terms.

³ Total gross investment does not necessarily represent an increase in wealth since part of gross investment constitutes replacement investment. Savings, however, must cover both replacement investment and any increases in the capital stock.

shown below:

$$(5) \quad \Delta B = S - \Delta M - I \quad (\text{residual demand for bonds})$$

The government budget constraint states that the budget deficit must be financed either by printing money or bonds, or that

$$(6) \quad G - T = \Delta M + \Delta B \quad (\text{government budget constraint})$$

where G represents government expenditures and T represents tax revenues. Rearranging equation (6) to solve for the residual supply of bonds, we see that

$$(7) \quad \Delta B = G - T - \Delta M \quad (\text{residual supply of bonds})$$

which simply states that the supply of bonds is equal to the size of the budget deficit minus any change in base money. In most macroeconomic textbook models, equations similar to equations (5) and (7) are used as the basis for omitting explicit reference to the quantity and interest rate on government bonds.

The decision to exclude the bond market in standard textbook presentations is generally made for ease of exposition. Since the supply of money is one of the government's principal policy instruments, its inclusion in textbook models facilitates the development of macroeconomic multipliers and the analysis of policy options.

Patinkin argues that the exclusion of the bond market is not necessar-

ily a good choice in practice, however. He has shown that, while the choice of market to exclude does not influence final market equilibriums, the choice does have implications for the dynamics of the system. In his comparison of the dynamics of models including the money market with an LM curve, versus the inclusion of the bond market with a BB curve, Patinkin concludes that the dynamics make more sense when the bond market is included.⁴ Given Patinkin's arguments, the bond market rather than the money market is included in COMGEM.

Walras Law and the government budget constraint can also be used to residually solve for the demand and supply of money. The algebraic manipulations required to exclude the money market are similar to those used earlier to exclude the bond market. Equations (5) and (7) must be respecified to solve for the change in money rather than the change in bonds. Solving instead for money, equations (5) and (7) would take the following form:

$$(5^*) \quad \Delta M = S - I - \Delta B \quad (\text{residual demand for money})$$

$$(7^*) \quad \Delta M = G - T - \Delta B \quad (\text{residual supply of money})$$

where the notation for numbering equations (5*) and (7*) indicate that these equations replace equations (5) and (7) in the model.

⁴ Patinkin's arguments relate to the direction of change in interest rates implied by the two curves whenever there is excess supply for both bonds and money. If there is excess supply in these two financial markets, there must be excess demand in the goods markets. Excess supply of bonds implies decreasing bond prices and higher interest rates. Excess supply of money implies declining interest rates. During a period of excess demand for goods, Patinkin argues that rising interest rates are more likely and thus inclusion of the bond market is more appropriate. A symmetric argument can be made for times when there is excess demand in both the bond and money markets.

If we use these two new equations to eliminate the quantity of money (M) and the return on money (r), the macroeconomic model outlined earlier in equations (1) through (3) can be restated as follows:

$$(1^*) \quad Y/P = c(Y/P, r_b, W/P) + i(Y/P, r_b) + g \quad (\text{the IS curve})$$

$$(2^*) \quad B/P = b(Y/P, r_b, W/P) \quad (\text{the BB curve})$$

$$(3^*) \quad P^o = P^{oe} + a(Y - Y_p)/Y_p \quad (\text{the AS curve})$$

The exclusion of the money market in the above model suggests at least one important implication for using COMGEM in policy analysis. In the model, monetary policy is transmitted through changes in government bonds held by the public rather than changes in the money supply. Fiscal policy is reflected by the level of government expenditures and tax rates. The Federal Reserve is then assumed to control the growth in money by deciding how many government bonds to buy rather than the conventional assumption of deciding how many reserves to create.⁵ This difference and its implications for the implementation of policy scenarios has, in the past, created some confusion. The problem has been one of communications rather than an error in theory or a deficiency in the model, however. The burden of translating requests for projections of the implications of different monetary growth rates is placed on the individual running the model. Moreover, descriptions of the assumptions underlying these projections must be stated in terms of

⁵ Purchases of government bonds account for only the nonborrowed reserves component of the monetary base. Two other exogenous variables are used in COMGEM - the discount rate and the level of currency - to control growth in other components of base money. The monetary base is then converted into maximum levels of deposits and bank loans based upon reserve requirements. These maximums help determine interest rates charged and paid by financial intermediaries.

the growth in government bonds held by the public rather than the growth in the money supply.⁶

Respecifying the AS curve

The aggregate supply (AS) curve presented in equation (3*) has been widely adopted in macroeconomic textbooks (see Gordon's book for example). It has many of the important properties deemed necessary in such a function. The first term on the right-hand side of equation (3*) can be interpreted as representing *cost push* inflationary pressures. Workers expecting a given inflation rate will bargain for increases in their wages. Producers also expecting the same level of inflation will likely grant such wage requests. The second term on the right-hand side of equation (3*) reflects *demand pull* inflationary pressures. As gross national product grows relative to the nation's potential output, inflation will increase. Equilibrium is achieved in the long run only when there are no surprises (i.e., when actual inflation equals expected inflation). This can only be true in equation (3*) when actual gross national product equals the nation's potential output. So, while equation (3*) allows for a short term dynamic trade-off between inflation and the unemployment of labor and capital, long run equilibrium satisfies the classical requirement of full employment.

Unfortunately, equation (3*) cannot be estimated in its present form since reliable data on general price expectations are unavailable. Assump-

⁶ The government budget constraint expressed in equation (6) is in reality not an exact identity. Thus, there is not a one-to-one correspondence between the growth in nonborrowed reserves and the difference between the deficit and growth in government bonds. In addition to selling bonds or printing money, the government can finance budget deficits through the sale of assets or the diminution of its bank accounts.

tions therefore must be made regarding the formation of inflationary expectations. In COMGEM, the expected level of inflation is assumed to be directly related to current and past rates of change in the money supply. The lagged relationships used in estimating the aggregate supply curve are based on the observation that changes in the money supply take time to affect prices and the presumption of adaptive expectations throughout the model.⁷ Using these assumptions, equation (3*) can be rewritten as follows:

$$(3^{**}) \quad P^o = \Theta_n (\Delta M) + a(Y - Y_p)/Y_p$$

where Θ_n represents an n period distributed lag.

In the standard textbook macroeconomic model, equation (3**) could then be directly estimated. In COMGEM, however, the elimination of the money market requires further substitution before estimation. Substituting the specification of the residual supply of money given earlier in equation (7*) into equation (3**), we see that

$$(3^{***}) \quad P^o = \Theta_n (G - T - \Delta B) + a(Y - Y_p)/Y_p.$$

Using the term DEF to represent the government's budget deficit and partitioning this deficit from bond financing, the AS curve actually included in the COMGEM model takes the form:⁸

⁷ Given the problems of estimating rational expectations models, their assumptions of free and rapid dissemination of information, and the observational equivalence of rational and adaptive expectations behavior, it is not clear the adaptive expectations models are inferior (see Conway and Barth).

⁸ Separation of the deficit from bond financing in this equation is

$$(3^{****}) \quad P^o = \theta_n(DEF) + \theta_m(B^o) + a(Y - Y_p)/Y_p$$

where θ_m represents an m period distributed lag and B^o is the growth rate for government bonds owned by the private sectors. Equations (1*), (2*) and (3****) form the theoretical basis of the entire COMGEM model.

Disaggregating the Product Market

Obviously the three-equation macroeconomic model developed above does not provide enough detail to identify the financial condition of farmers or the variety of real and financial linkages between the farm sector and the rest of the economy. Information regarding the farm sector is included in these equations, however. Farmers' consumption expenditures are included in c , their investment expenditures are included in i and their demand for government bonds is reflected in the BB curve. Thus, instead of developing a separate farm sector model, farmers' decisions are separated from those of other consumers and producers in the economy by disaggregating the equations and data in COMGEM.

In disaggregating the model, six different groups of transactors in the economy are specified. In COMGEM, *farm operator families* (FOF) receive major attention. They act as producers of raw agricultural commodities, consumers of final products and the residual claimant of farm profits. Five other groups of transactors are explicitly identified in COMGEM. *Other domestic consumers* (ODC) account for most of the final demands for products in the economy, own the means by which nonfarm products are produced, and

done to accommodate the fact that the government budget constraint is not an exact identity (see footnote 6).

offer their labor services in farm and nonfarm labor markets. *Nonfarm businesses* (NFB) provide some farm inputs, supply all domestically-produced final consumer goods, hire labor and arrange for the financing of their firms. *Financial intermediaries* (FI) provide markets which equate the supply of savings with the demand for loan funds. *Government* (GOV) purchases farm and nonfarm goods, hires labor, implements monetary, fiscal and farm program policies, collects taxes and finances budget deficits. Finally, the *rest of the world* (ROW) purchases U.S.-produced farm and nonfarm products as well as government securities. In addition, they supply primary inputs such as petroleum as well as final consumer goods.⁹

The aggregate IS curve stated earlier in equation (1*) can be restated as simply the sum of the actions of the individual transactor groups, or

$$(1^{**}) \quad Y/P = \sum_{i=1}^{nc} c_i + \sum_{j=1}^{ni} i_j + g$$

where c_i represents the real consumption expenditures made by the i^{th} transactor group, i_j is the real investment expenditures made by the i^{th} transactor group, nc represents the number of consuming groups (FOF, ODC and ROW) and ni represents the number of investing groups (FOF and NFB).

Dissaggregation of the types of consumption and investment goods and services being marketed in the economy must also occur to expand the system to include the details required to answer questions about the financial condition of the farm sector. The dichotomy between durable and nondurable

⁹ More detailed information on the international linkages in COMGEM is provided later in this paper.

consumer goods found in most macroeconomic models is preserved in COMGEM. In addition, food is separately identified as a consumer good. Thus, there are three consumer goods in the COMGEM model: food, consumer durables and nonfood nondurable goods and services. The disaggregation of investment in the farm sector is far more detailed than it is for nonfarm businesses in the model. Farm investment is traced to investments in machinery and motor vehicles, buildings, inventories and land. Only investments in land and capital equipment are individually identified for nonfarm businesses.

Total consumption and investment for each transactor group is simply the sum of the consumption and investment expenditures made by these groups for the individual goods and services. Thus, the real consumption expenditures by the i^{th} group are equal to

$$(1a) \quad c_i = \sum_{k=1}^{mc} c_{ik}$$

where mc represents the number of consumer goods. The real investment expenditures by the j^{th} group are equal to

$$(1b) \quad i_j = \sum_{h=1}^{mi} i_{jh}$$

where mi is the number of investment goods. Thus, equation (1**) can be rewritten as follows:

$$(1^{***}) \quad Y/P = \sum_{i=1}^{nc} \sum_{k=1}^{mc} c_{ik} + \sum_{j=1}^{ni} \sum_{h=1}^{mi} i_{jh} + g.$$

The value of consumption or investment in an individual good by a specific transactor group is equal to the price of the good times the quantity purchased.¹⁰ These prices and quantities are provided by the standard industry-level demand and supply equations in COMGEM. For example, the equations for consumption goods take the general form:

$$(8) \quad q_{ij}^d = d(p_j, \phi p_o, c_i) \quad (\text{demand})$$

$$(9) \quad q_j^s = s(p_j, \phi p_o, \phi p_u) \quad (\text{supply})$$

$$(10) \quad \sum_{j=1}^{nc} q_{ij}^d = q_j^s \quad (\text{market clearing equation})$$

where q_{ij}^d represents the quantity of the j^{th} good demanded by the i^{th} group, p_j is the own price of the j^{th} good, c_i represents total consumption expenditures by the i^{th} group (which acts as a budget constraint), q_j^s is the quantity of the j^{th} good supplied, ϕp_o represents a vector of the prices of all other consumer goods, and ϕp_u represents a vector of the prices of all the inputs used in the production of the j^{th} good. Forcing equilibrium using the market clearing equation allows us to solve one of the demand or supply equations for the price of the j^{th} good. Given these

¹⁰ These prices are not nominal but are relative prices deflated by the numeraire. Since real consumption and investment is used in measuring real gross national product. Thus, the industry-level supply and demand equations are homogeneous of degree zero in prices. Other equations such as those determining taxes and after-tax real interest rates are influenced by the price level and its rate of change in the COMGEM model.

prices and quantities, consumption for each transactor group and for each good can be calculated and aggregated to determine total consumption.

For investment, an additional equation is needed to account for depreciation since we want to determine *gross* national product. This equation takes the following form:

$$(11) \quad i_{jh} = p_h(q_{jh} + D_{jh}) \quad (\text{real gross investment})$$

where i_{jh} represents real gross investment in the h^{th} capital good by the j^{th} group, p_h is the real price of this capital good, q_{jh} is the quantity of the h^{th} capital good added to the capital stock of the j^{th} group and D_{jh} is the depreciation of the h^{th} capital stock owned by the j^{th} group. Thus, the following four equations are used in COMGEM to solve for the price, net increase in capital stock, depreciation and quantity supplied for each investment good:

$$(12) \quad q_{jh}^d = d(p_h, r_b, \phi p_o, 0, t, K_{t-1}) \quad (\text{demand})$$

$$(13) \quad q_h^s = s(p_h, \phi p_o, \phi p_u) \quad (\text{supply})$$

$$(14) \quad D_{jh} = e\left(\sum_{i=1}^{\infty} q_{j,h,t-i}\right) \quad (\text{depreciation})$$

$$(15) \quad q_h^s = \sum_{j=1}^{ni} (q_{jh}^d + D_{jh}) \quad (\text{market clearing equation})$$

which, when solved, provide the information needed to develop the investment component of real gross national product allowed for earlier in equation (1***). Those variables not previously defined include the tax rate

(t), the quantity of output (O) and the lagged capital stock (K_{t-1}). Note that the determinants of investment - income and the interest rate - specified in equation (1) are included in equation (12), but with some extra detail. Income is represented by the prices and quantities of outputs. The interest rate is reflected in an implicit rental cost of capital which accounts for the price of capital, the method of financing and taxes. The lagged capital stock is included to reflect a partial adjustment hypothesis.

The disaggregated supply equations identified above provide a direct linkage between the particular transactor group in question and: (1) primary and secondary input markets and (2) the relative prices and quantities in final goods markets. Farmers (FOF), for example, create raw agricultural commodities by using primary inputs such as land and labor in combination with intermediate goods such as machinery and chemicals supplied by other groups. The derived demand functions for inputs used in farm production as well as the supply of these inputs are included in COMGEM. Thus, production expenses are related to the equilibrium prices and quantities of the inputs purchased, and the profitability of the sector is endogenously determined.

Table 1 presents a simplified illustration of the disaggregated IS curve in COMGEM. This figure shows how the different sectors of the economy interact although the goods markets shown are not as disaggregated as those in the model. COMGEM, for example, includes commodity-level detail for the major crops, livestock and livestock products produced in this country. Quantities of raw agricultural products are marketed by the FOF and ROW transactor groups and are purchased for processing by the NFBs and storage by the GOV. The supply and demand equations represented in Table 1

Table 1 Disaggregation of the IS Curve in COMGEM: Sectorial Demands and Supplies

Goods	Farm Operator Families	Other Domestic Consumers	Nonfarm Products Sector	Financial Interme- diaries	Govern- ment	Rest of the World
Primary						
Inputs:						
Land	D*	D	D, S*	D		
Labor	D, S	S	D		D	
Petroleum			D			S
Secondary						
Inputs:						
Capital stock	D		D, S			
Manufactured inputs to farming	D		S			
Raw agricul- tural products	S		D		D	S
Final						
Products:						
Food	D	D	S		D	D
Consumer Durables	D	D	S			
Other	D	D	S		D	D

*D and S represent demand and supply functions, respectively.

provide the quantities and relative prices required to calculate real gross national product (Y/P) in the IS curve given: (1) the simultaneous solution for interest rates from the BB curve and (2) the general price level from the AS curve.

Disaggregation of Financial Markets

Financial markets also need to be disaggregated to capture the linkages between the farm sector and the rest of the economy and to determine the financial condition of the sector. Unlike the disaggregation of the IS curve, however, expansion of the BB curve to account for government bonds is not sufficient. With the exception of all financial assets other than money and government bonds, cancel out in the standard textbook macroeconomic model. Once sectors are partitioned, however, there is a need to account for each sector's financial instruments since the liabilities of one group are no longer cancelled by the assets of another group.

This expansion of the number of financial instruments is one of the principal differences between aggregate macroeconomic analysis and standard microeconomic theory. It is also a principal reason why previous documentation of our modeling efforts proceeded from the micro to the macro. Some who have an understanding of the standard textbook macroeconomic model may feel that many of the financial asset equations appearing in a multi-sectored general equilibrium model are included on an ad hoc basis. Their inclusion, of course, is *not* ad hoc. In microeconomic theory, the demands and supplies of financial instruments can be developed using portfolio balancing theory (see Tobin, Penson).

Seven financial markets are included in COMGEM. As shown in Table 2,

Table 2 Disaggregation of the BB Curve in COMGEM: Sectorial Demands and Supplies

Goods	Farm Operator Families	Other Domestic Consumers	Nonfarm Products Sector	Financial Interme- diaries	Govern- ment	Rest of the World
Demand deposits	D*	D	D	S*		
Time deposits	D	D	D	S		
Commercial bonds		D	D,S	D		
Government bonds		D	D	D	S	D
Equities		D	S	D		
Farm Debt:						
Real estate	D			S		
Nonreal estate	D			S		
Bank loans		D	D	S		

*D and S represent demand and supply functions, respectively.

demand deposits and time and savings deposits are assets held by the FOF, ODC, NFB and ROW transactor groups. These deposits also represent liabilities of financial intermediaries (FI). Commercial bonds, bank loans and equities finance the NFB group. Government bond markets are included to help capture the financial implications of monetary and fiscal policies. Farm loans and loans to consumers are also included.

The general forms of the supply and demand equations for financial instruments are described in the following two equations:

$$(18) \quad S_{ij}^d = d(r_j, \phi Spa_i, \phi Sfa_i, \phi Sdt_i) \quad (k \neq j) \quad (\text{demand})$$

where S_{ij}^d represents the demand for the j^{th} financial instrument by the i^{th} sector, r_j is the rate of return on the j^{th} asset or interest rate on the j^{th} liability, and ϕSpa_i , ϕSfa_i and ϕSdt_i (where $k \neq j$) represent vectors of the stocks of physical assets, other financial assets and liabilities in the i^{th} sector, respectively. The rates of return (interest) on assets (liabilities) are represented by:

$$(19) \quad r_j = s(\sum_i S_{ij}^d, \phi r_o) \quad (k \neq i) \quad (\text{supply})$$

where r_o represents a vector of rates of return (interest) on other assets (liabilities) relevant to the supplying sector.

International Linkages

Most of the linkages between the domestic and foreign economies that

have an impact on agriculture are captured in COMGEM. The existence of linkages through the supply of raw agricultural products, demands for food and nonfood consumer goods, and the purchase of government bonds by the ROW transactor group has already been discussed in the previous section. The factors that influence these demands and supplies have not been described, however, and this section presents their development in COMGEM.

COMGEM is well suited to capturing the growing dependence of the U.S. economy on world trade, and projecting the consequences of changes in world economic conditions at the sector level. Rather than having an IS curve with net exports listed as a separate item in calculating gross national product, the components of net exports have been identified and included as demands and supplies in individual markets.

Currently, the imports and exports of raw agricultural products and food are exogenous variables in the model.¹¹ As such, the individual running COMGEM must determine how these variables will change given the values of other exogenous variables used in projecting future conditions. It is probably impossible to reliably predict the imports or exports of agricultural products in a mechanical way, due to the unpredictability of purchases by centrally-planned economies and the variability of world weather conditions. There are, however, some systematic reactions of world markets to changes in U.S. policies. Such reactions would include decreases in U.S. agricultural exports when the value of the U.S. dollar increases, or the impacts of world population growth on U.S. agricultural exports. Identifying and incorporating such reactions is a significant future research pro-

¹¹ Imports and exports of specific agricultural commodities have been exogenized in the current version of COMGEM. Imports and exports of crops, livestock and food were endogenous in GEM.

ject, but it is important to note that COMGEM has been constructed to include the affects of changes in world agricultural trade.

Some of the largely nonagricultural impacts of changes in the condition of the world economy are included in COMGEM. The U.S. balance of trade and the exchange rate are captured endogenously in reduced form equations. The exchange rate equation is driven by the industrial production in foreign developed countries, the growth of non-U.S. population and the domestic balance of trade, gross national product and rate of inflation. The U.S. balance of trade is explained by the exchange rate and the prices and quantities of U.S. exports and imports.

Other international linkages include the net imports of nonagricultural goods and capital flows. Net imports of nonagricultural goods are determined by the exchange rate, the industrial production of foreign developed countries and the prices of U.S. agricultural and nonagricultural goods. Capital flows are represented by the demand for U.S. government bonds by the ROW group. Foreign holdings of U.S. government bonds are related to the exchange rate, the industrial production of foreign developed countries, the U.S. balance of trade and the interest rate on government bonds.

The exogenous driving forces of the nonagricultural international linkages in COMGEM are limited to foreign population growth and a measure of the industrial production in the developed nations. The systematic variations in variables determined by the relationship of these exogenous forces and conditions in the domestic economy are endogenously determined. While the specification of many of these relationships are admittedly naive, they have served to keep the model sensitive to major changes in

worldwide economic conditions.

Summary

The nineteen equations presented in this paper form the theoretical macroeconomic structure of the COMGEM model. Individual sector supplies and demands for both real and financial goods and services are aggregated within the model to produce macroeconomic results. When derived from the standard textbook model, the equations in COMGEM can be seen to be relatively standard in their construction. The major differences between COMGEM and other macroeconomic models lie in (1) the manner in which monetary policy is introduced, (2) the use of portfolio balancing theory to capture the disaggregated financial markets needed in a multi-sector model and (3) the attention given to the farm sector.

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THE THEORETICAL STRUCTURE OF FARM SUPPLY
RESPONSE AND PRICE DETERMINATION IN COMGEM

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THE THEORETICAL STRUCTURE OF FARM SUPPLY RESPONSE AND PRICE DETERMINATION IN COMGEM

Robert F. J. Romain

The two previous presentations by John Penson and Dean Hughes discussed the origin and general equilibrium structure of the Commodity-Specific General Equilibrium Model, or COMGEM. This presentation will address the theoretical structure underlying farm output response in the model as well as the equilibrium market price determination mechanism for crops and livestock. The first section of this paper will focus on crop production and prices. Here, the general approach to modeling output supply, market demand and the determination of market prices under conditions of government intervention will be presented. The second section will focus on the general approach taken to determining these quantities and prices for livestock. Finally, the general approach taken for milk production and the determination of its market price will constitute the third and final section of this paper.

Crop Production and Prices

The purpose of this section is to outline the general approach taken to modeling the output response for seven major crops produced in the U.S. (wheat, corn, oats, barley, sorghum, cotton and soybeans), the transmission mechanisms for commodity policy, the farmers' formulation of expected farm prices and the determination of equilibrium market prices and quantities.

Output response

Total output for a given crop is defined in the COMGEM model using the following identity:

$$(1) \quad Q_i \equiv h_i \cdot A_i \cdot Y_i \quad (\text{output for } i\text{th crop})$$

where Q_i represents the total output of the i th crop, h_i is the proportion of harvested acres to planted acres for the i th crop, A_i represents the total acres planted for this crop and Y_i is the average yield or output per acre for the i th crop.

Assuming expected profit maximization subject to the constraints imposed by government intervention, the general form of the acreage response and yield equations in the COMGEM model can be expressed as follows:

$$(2) \quad A_i = A_i(C_i, FP^e, GP) \quad (\text{acreage response for } i\text{th crop})$$

$$(3) \quad Y_i = Y_i(C_i, FP^e, GP) \quad (\text{yield per acre for } i\text{th crop})$$

where C_i represents a vector of implicit rental costs for inputs used in producing the i th crop, FP^e is a vector of expected farm prices for this and other farm products and GP represents a vector of government policy variables. Equations (2) and (3) indicate that both the acreage response and yield per acre are related to the implicit cost of inputs used to produce the crop, all expected farm prices and some variables reflecting the tools used by the government to intervene in the sector.

Government intervention

Several approaches have been proposed in the literature to reflect the different forms of government intervention in crop production. Some have included such policy variables as diversion payments per acre, allotments, loan rates and target prices (see Garst and Miller; Just; Yeh; Lidman and Bawden; Morzuch, Weaver and Helmberger). These studies generally incorporated the policy variables in a linear fashion. Another approach to capturing government intervention in the farm sector is the concept of *effective support price* initially proposed by Houck and Subotnik. This approach weights the announced support price by an adjustment factor which accounts for the planting constraints attached to obtaining this guaranteed price. The effective support price can be thought of as the price level that would have to occur under free market conditions for planted acres to be at the restricted level. If there are no planting restrictions, the effective support price would be the same as the announced price support. The more restrictive program requirements become, the lower the effective support price will be. Realizing that a single variable cannot adequately reflect all government programs, Ryan and Abel extended the concept of the *effective support price* to the development of an *effective diversion payment* as well. The effective support price is combined with the expected market price to form the expected farm price in COMGEM in a manner described shortly. The expected farm price (FP^e) plays an important role in COMGEM since it was shown in (2) and (3) to affect both yields per acre (Y) as well as acres planted (A). The concept of effective diversion payments is also used in this model. Government intervention is thus represented through two variables in COMGEM: the *effective support prices* and *effective diversion payments*.

Expected farm price for crops

Most acreage or output response studies examining the effects of government intervention have recognized that farmers react to an *expected price* when making their planting decisions. Nerlovian adaptive price expectations have been used extensively with different degrees of lags. When the coefficient of expectations is assumed to be one, the price expectation reduces to the previous year's price. This naive formulation of expected farm price implies a recursive response from farmers that is likely not appropriate in a regulated environment.

Studies by Gardner, as well as by Morzuch, Weaver and Helmberger used the *futures price at the time planting decisions are made* as expected farm price in their studies. Both studies concluded that the variable gave reasonable results and should be considered as an alternative to using distributed lags in modeling price expectations. The *effective support price* initially proposed by Houck and Subotnik has also been used to reflect farmers' expectations. However, since the effective price is closely tied to the level of the price support, it cannot adequately reflect farmers' response when market prices are well above support levels, as was the case in the mid-seventies. This limitation was recognized by Houck et al. Another proxy was used in their study to reflect farmers' expectations during those years.

Information on futures prices at the time planting decisions are made is reflected in the COMGEM model in the following manner. Assuming farmers actually use futures prices at planting time when forming their price expectations, they are likely to be influenced by how efficient futures prices have been in the past in forecasting the eventual actual market

price. It is assumed in COMGEM that farmers weight current futures market information when forming their expectations about market prices in time period t :

$$(4) \quad EP_t^m = \left[\sum_{j=1}^3 (P_{t-j}^m / P_{t-j}^F) W^j \right] P_t^F \quad (\text{expected market price})$$

where EP_t^m represents the expected market price in period t , P_{t-j}^m is the actual market price in period $t-j$ and P_{t-j}^F represents the futures price in period $t-j$.

This expected market price formulation implies that farmers weight geometrically the predictive performance of futures prices over the previous three periods and apply this weight to the current futures price when forming their expected market price. For example, if futures prices at planting time for delivery at harvest time have accurately forecasted the market price, then EP_t^m will be at or near P_t^F . If futures prices in recent years have been usually lower (higher) than the price farmers actually received, their expected market prices for the coming year will be higher (lower) than the current futures prices.

Equation (4), therefore, gives farmers' expected market prices for the upcoming period based on the current futures prices. Importantly, however, it is possible for this expected market price, especially since the inception of the target prices in 1973, to be lower than the support price. In such cases, farmers are likely to react to the higher target price. If so, use of the expected market price given by equation (4) would underestimate farmers' output response. Use of the target price could also be misleading,

however, since program participants often have to divert – or set aside – a certain number of acres in order to be eligible to participate in the programs. The *effective support price* would be more appropriate in such instances since it reflects the effects of acreage restrictions.

The expected market price formulation expressed in equation (4) and the effective support price, which was developed following the concept originally proposed by Houck, et. al., have been combined in COMGEM to represent the *expected farm price* at planting, or the FP^e variable appearing in equations (2) and (3). We shall not present the programming algorithm used to calculate the expected farm price here since it is quite involved (see Romain and Penson). The major characteristics of the expected farm price, however, suggests that when the market is weak, the effective support price is considered by farmers as their expected farm price. In fact, if the expected market price is *lower* than the effective support price, the expected farm price is set equal to the effective support price (i.e., $FP^e = P^S$ where P^S represents the effective price support). Strong market conditions causing the expected *market* price to increase will cause the expected *farm* price to increase as well. Furthermore, the larger the difference between the expected market price and the effective support price the closer the expected farm price will be to the expected market price. Implicit in this expected farm price formulation therefore is the assumption that the participation rate in the programs decreases at an increasing rate with the difference between the expected market price and the effective support price.

Prices and quantities marketed

Once planting is complete, the available supply in any given year is relatively inelastic even though the ultimate level of production can vary slightly with the degree of utilization of some variable inputs and with weather conditions. It is therefore possible to estimate a *quantity demanded* equation and solve explicitly for the market price. The general framework of such a system is given by the following equations:

$$(5) \quad QS_i \equiv Q_i + M_i - FC_i - \Delta KFM_i \quad (\text{supply})$$

$$(6) \quad QD_i = QD[P, W, KCOM_{t-1}, QD_{t-1}] \quad (\text{demand})$$

$$(7) \quad KGV = KGV_{t-1} + (QS - QD) \quad (\text{ending government stocks})$$

where QS_i represents the quantity of the i th crop supplied, Q_i is the total output of this commodity during the period, M_i is the quantity of the i th commodity imported, FC_i represents the farm consumption of this commodity, ΔKFM_i is the change in the ending stock of the i th commodity owned by farmers, QD_i represents the quantity of this commodity demanded by processors and other nonfarm entities, KGV is the ending government stock, P is a vector of output prices relevant to processors, W is a vector of input prices processors are faced with and $KCOM_i$ represents ending commercial stocks of the i th commodity.

Equation (5) gives the total quantity available for marketing from the private sector for a given period. The quantity Q_i comes from the supply side of the market and is affected by the acreage response and yield res-

ponse as shown in equation (1). Farm consumption (FC_1) is also determined endogeneously in COMGEM. Since this quantity is not marketed as such, however, it is not included in the quantity supplied. Nor are variations in farmers' inventories (ΔKFM_1) for the same reason.

Equation (6) reflects the quantity demanded for a given set of economic conditions, and includes a Nerlovian partial adjustment. Equation (7) is the balancing equation which states that government stocks increase by the difference between the quantity demanded and total supply when the market price reaches a lower bound, which is the announced loan rate. Similarly, when demand exceeds the available supply and the price rises to the release price, government stocks decrease by the difference between the quantity demanded and the quantity supplied at this price level. However, if government stocks reach a minimum acceptable level in COMGEM, free market forces apply and the price increases enough for demand to equal supply.

Livestock Production and Prices

The framework for the livestock equations in COMGEM reflects the dynamic nature of livestock production captured by the lags between the time the decision to produce is made and the time the final output goes to market. As was the case for crops, once the decision to produce has been made and resources have been allocated, the production process is largely irreversible.

Output response

A review of the literature on livestock supply response models rev-

ealed the following shortcomings: (1) the breeding stock, which biologically contributes to the potential supply is either nonexistent (Chen, Heien) or exogenous (Cromarty), (2) either input costs are ignored in the determination of the desired breeding stock (Arzac and Wilkinson, Crom) or only a few *variable* input prices are included (Salathe, Price and Gadson; Kulshreshtha and Wilson; Tryfos), and (3) the relative prices of other products reflecting possible substitution among production activities were omitted.

The specifics on the modeling of livestock output response in COMGEM are presented in technical papers available upon request. I would like to take this opportunity to identify some of the general relationships which determine the level of output in COMGEM.

The optimal stock of breeding animals in the model is expressed as a function of all expected agricultural output prices, the implicit rental costs for all inputs and the potential number of animals ready to enter breeding herds. The lagged value of the dependent variable is included to reflect a partial adjustment process. Gross replacement of breeding animals is given by the summation of the net change in breeding livestock less the number of animals that died or were slaughtered during the period. The total crop of the *i*th category of livestock is then related to the beginning stock of breeding animals as well as to gross replacement. The slaughtering of breeding animals has the same theoretical structure as the optimal stock equation, although the beginning stock is included to reflect the aging of the existing breeding stock. It is hypothesized that the larger the beginning stock in any particular period, the greater the number of older animals slaughtered during the upcoming period.

The supply of livestock reflects the biological nature of livestock production. Economic incentives are reflected only indirectly. Therefore, most of the supply is determined by previous outputs (with an appropriate lag), the size of the optimal breeding stock and farm consumption. The implicit rental costs of nondurable inputs are also included in the supply equation. Assuming inputs show decreasing marginal productivity, an increase in input prices would imply a decrease in the optimal input use. Taking the price of feed as an example, decreasing the ration would imply a longer time period to reach the same weight and hence decreased slaughtering in the current period. Reaching a given market weight could still be the optimal economic decision due to the pricing system which differentiates among grades of meat. On the other hand, the same price increase could imply a lower optimal slaughtering weight, thereby requiring a shorter feeding period and an increase in animals slaughtered during the period. The sign on these variables, therefore, was left to empirical estimation.

Finally, farm slaughter is treated as a demand for meat. Its structure implies a utility maximizing behavior. The explanatory variables therefore include the prices of all other goods entering farmers' utility functions as well as farmers' income from all sources, which reflects their budget constraint.

Expected farm price for livestock

The structure of farmers' expected price for livestock in COMGEM is similar to the expected *market* price for crops outlined earlier. Farmers are assumed to geometrically weight the previous three year's prices, thus emphasizing recent events. Rather than adjusting the futures price at

planting time, however, farmers in COMGEM are adjusting the price they received in the most recent period.

Prices and quantities marketed

Since supply is relatively inelastic in any given period, processors' demand is better expressed as an inverted demand equation which uses price as the dependent variable. As discussed by Heien, adjustment in demand created by changes in other prices relevant to processors must be captured in the price direction. The demand equations for culled breeding stock and market animals are therefore expressed in the COMGEM model as follows:

$$(8) \quad FPBR_i = B_i(BRSL_i, FPLV_j, PC)$$

$$(9) \quad FPLV_i = L_i(LVSL_i, NMLV_i, FPLV_j, RPLV, PC)$$

where $FPBR_i$ represents the cull price for the i th category of livestock, $BRSL_i$ represents the quantity of the i th category of breeding animals available for slaughter, $FPLV_j$ is a vector of prices received by farmers for other categories of market animals, PC represents a vector of implicit rental costs incurred by processors, $FPLV_i$ is the price received by farmers for the i th category of market animals, $NMLV_i$ represents net imports and $RPLV$ is a vector of retail prices for all categories of livestock products.

Milk Production and Prices

Milk production in COMGEM builds heavily on the dairy cattle equations contained in the livestock component of the model described in general terms in the previous section. Total output is defined to be the product of

average production per cow and the average number of cows on farms during the period. This section discusses the determination of milk production and the manner in which government intervention is reflected in COMGEM. The formulation of farmers' expected price and the determination of market prices and quantities are also discussed.

Output response

Several studies of output response for milk found the supply of milk to be more responsive to lagged prices than to the current price (see Wilson and Thompson or Chen et. al., for example). It is hypothesized in COMGEM that this lagged effect is due to an adjustment in the optimal stock of dairy cattle (which takes time and involves longer-run expectations) and that farmers react quickly to optimal short-run adjustments required by changes in relative prices in the current period. To adequately model short-run milk production, Halvorson suggested that "we are essentially forced to focus on the factors that give rise to short-run changes in production per cow" (p. 1191). Longer-run impacts are appropriately captured in the stock formation of the dairy herd. Milk production in COMGEM is given by the following two equations:

$$(10) \quad \text{MKCOW} = M(\text{FPMK}, \text{CND}, \text{Z}, \text{MKCOW}_{t-1})$$

$$(11) \quad \text{MKPROD} \equiv \text{MKCOW} \cdot \text{COW}$$

where MKCOW represents milk output per cow, FPMK is the average price received by farmers for all milk, CND is a vector of implicit rental costs of nondurable inputs, Z is a vector of variables reflecting technological

and biological improvements, MKPROD represents total milk production and COW represents the average number of cows during the period.

Equation (10) suggests that average milk production per cow which is related to the average price received for all milk during the current period, the implicit rental costs of nondurable inputs and variables reflecting technological and biological improvements to dairy herds. The value of the lagged dependent variable in this equation accounts for delays in production adjustments. Total milk production is defined in equation (11) as the average output per cow multiplied by the number of dairy cows. The functional structure representing the variable COWS was discussed in general terms in the previous section.

Government intervention

Government intervenes at both the farm and retail levels in the case of milk. Let us concentrate on the support price program which *directly* affects farm prices. The support price program for milk guarantees a minimum price to farmers for manufacturing grade B milk. Since fluid milk cannot be stored, the government purchases manufactured products such as butter, cheese and dry milk when their support price is reached. The support price does not explicitly appear in the output response formulation expressed in equations (10) and (11). However, the support price implicitly affects supply through the average price received by farmers. The fact that the Commodity Credit Corporation buys manufactured milk products when market conditions are weak, and releases stocks when market conditions drive their price above the announced release price, directly affects the average farm price received by farmers. This government intervention should

therefore be reflected in the formulation of farmers' expected price since this variable is instrumental in determining the desired stock of dairy cows. Government intervention should also be accounted for when market prices and equilibrium quantities are determined.

Expected farm price for milk

If market conditions are weak and government stocks are accumulating, farmers are guaranteed a minimum price for their manufacturing Grade B milk. At the aggregate level, the average price received for all milk should be somewhat higher than the support price since most of the milk is marketed through Federal marketing orders. Federal orders classify milk into different classes and guarantee premiums to producers according to the ultimate use of the product. However, if market conditions strengthen, free market forces will determine prices once CCC stocks reach acceptable minimum levels.

An expected price formulation which would account for both possible market conditions discussed above is therefore needed. The derivation of the expected *farm* price for milk used in COMGEM is again based on two expected prices: the expected price under support and the expected market price. The expected price under support suggests that farmers compare the average prices they received for milk to the announced support prices in the previous three years, weight them geometrically to emphasize the most recent price, and expect that the minimum average price for the current year will carry a similar weight. This weighting system is similar to the one used and the expected market price derivation. For example, if the weighted ratio of average prices for the last three periods is 1.2, farmers

will expect an average price in the current period which is 20 percent higher than the announced support price. This formulation of the expected farm price assumes a continuous government presence in the sector. This is one reason why the term "minimum" is used in the above discussion. The expected market price uses a similar set of weights but incorporates the most recent average price received in place of the announced price support. Both expected prices are then combined to derive the *expected farm price*.

The programming algorithm used to calculate the expected farm price for milk in COMGEM is not presented in this paper due to its relative complexity. Some of its major characteristics can be summarized here, however. For example, when the expected price under the support price program exceeds the expected *market* price, the expected *farm* price is set equal to the expected price under support. If the the expected price under support is lower than the expected *market* price, the expected *farm* price will be in between these two prices. The greater this price differential, the closer the expected *farm* price will be to the expected *market* price. For example, if the expected *market* price is 20 percent higher than the support price, the weight associated with the expected *market* price when calculating the expected *farm* price will be 20 percent larger than the weight assigned to the expected price under support. This general formulation allows for say the simulation of a gradual withdrawal of government intervention and simulation of the impacts of a shift in the demand for milk and milk products.

Prices and quantities marketed

The general framework for the determination of prices and quantities marketed for milk follow the general approach described earlier for crops.

The major differences are that (1) two differentiated products are being modeled (fluid and manufacturing grade milk), (2) the support price program is related to manufacturing grade milk only and (3) retail prices are affected by the final price level of manufacturing grade milk. The specifics are not described here but are presented instead in technical papers available upon request. A few general comments about this determination are offered below.

The total supply of milk available for marketing during the period is determined by total domestic production, discussed earlier, net imports and the quantity of milk fed to calves. However, in a regulated market, processors' demand does not necessarily have to equal the available supply. If the equilibrium price for manufacturing grade B milk is below the announced support price or above the announced release price, government stocks will be adjusted to either support or suppress the market price. Of course, if demand pressures are such that government stocks are driven to minimum acceptable levels by the government, market forces will operate freely and the market clearing price will be solved for explicitly in the model.

The price received by farmers for fluid milk is defined to be the price they receive for manufacturing grade milk plus a margin reflecting the exogenously determined impacts of the Federal marketing orders. The relationship between retail prices and quantities marketed are assumed to be recursive.¹ Processors are assumed to fix the retail price in the current period according to the previous demand as well as to their manufacturing costs. The retail price of manufactured milk products is therefore

¹ Empirically, the recursive relationship between prices and quantities marketed was far superior to the specification using current quantities.

related to the price received by farmers for manufacturing grade milk, total demand in the previous period and a vector of all implicit rental costs relevant to processors. A similar formulation was adopted for the determination of the retail price for fluid milk.

Summary

The incorporation of the crop, livestock and livestock product equations discussed in this paper in the COMGEM model allows for the analysis that farm program policy will have on the output, prices and stocks of these commodities as well as on the financial structure and economic performance of agriculture. The combination of effective program benefits and market information in formulating the expected farm price of these commodities builds upon past research conducted by others in modeling output response in agriculture.

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THE MSU AGRICULTURE MODEL

BY

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Introduction



The MSU Agriculture Model Project provides a unique perspective from which to analyze current and future market conditions and anticipate their impact on world agriculture. The total project encompasses a comprehensive econometric simulation model and supporting services provided by the Department of Agricultural Economics at Michigan State University. The Project is partially financed by contract research and subscriptions to the forecast report.

The MSU Agriculture Model was developed under the guidance of a committee of concerned agribusiness users. The resulting project is uniquely tailored to the needs of agricultural decision makers operating in the complex world of agriculture today.

In order to capture the impact of change in export and import behavior of major regions or countries, the **International Component** of the Model consists of nine regions. These

regions include industrialized markets, less developed markets and centrally planned markets.

The International Component is unique among agricultural simulation models because of the detail of the endogenized (internally determined) international sector. The Model simultaneously determines world and U.S. prices and trade based on regional commodity conditions. The International Model captures the dynamic linkage of international markets and the U.S. agricultural economy.

The **Farm Income Component** of the model has become increasingly useful. This component draws from the commodity forecasts and summarizes the combined effects of inflation, government programs and productivity on aggregate farm input expenditures and net income position.

Analysis derived from the **U.S. Domestic Component** and from the

entire Model is supported by members of the Michigan State University Department of Agricultural Economics. These professionals have a wide range of expertise and are involved in applied research and extension with farmers, agricultural credit agencies, agribusiness and government.

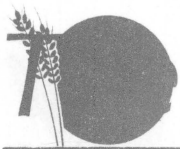
The MSU Agriculture Project provides annual forecasts for up to 10 years. These annual forecasts are issued twice a year. The Model is uniquely suited to intermediate and long-run strategic planning because it is based on an annual model. Annual models have proven to be more reliable and consistent than standard quarterly models for longer-run forecasts. In addition, the three components of the model—international, domestic and farm income—are interlinked. This system of checks and balances adds to the reliability and credibility of the model forecast.

Applications

The MSU Agriculture Model is designed to:

- provide long-term forecasts and scenario analysis of the agricultural economy to aid in strategic business planning and capital investment decision making,
- supply intermediate-term forecasts of commodity prices, quantities and exports for outlook and policy analysis,
- simulate the impact of government policy actions such as U.S.

commodity policy, European Community programs and GATT initiatives on the domestic and international agricultural economies.



Semi Annual Forecast

Subscribers to the MSU Agriculture Model receive a forecast of commodity prices, exports, production and farm income for each year up to ten years.

The forecast is published in the spring and in the fall. The report provides a thoughtful discussion of the underlying factors in international trade, the domestic outlook (by commodity), the impact of government programs and farm income.

The report is fully documented and is illustrated with easy-to-read charts and graphs, such as shown in Figure 1. The most important and dynamic trends are summarized in a concise 2- to 3-page executive summary.

As part of our basic service, we invite clients to call and discuss questions regarding the report.

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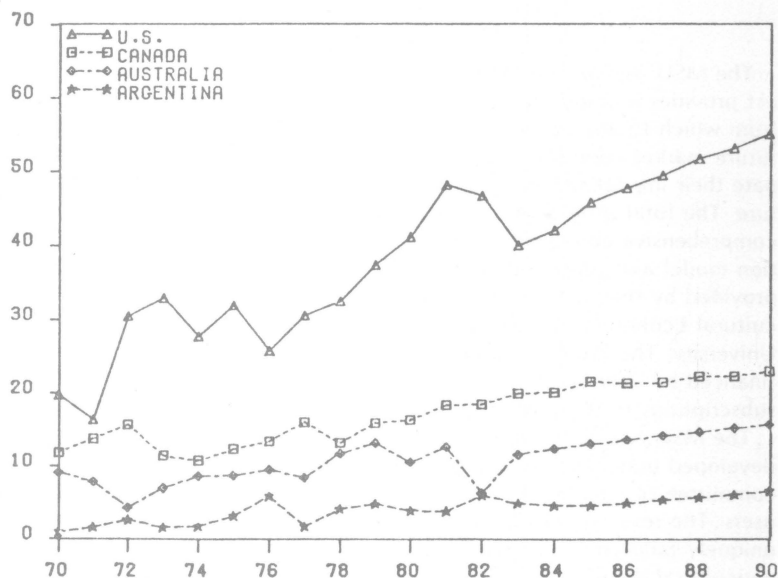


Figure 1—Wheat Net Exports, Primary Regions, 1970-82.

Semi Annual Forecast Table of Contents

Executive Summary

International Agricultural Outlook

Introduction — Overview

Wheat

Coarse Grains

Soybeans

Domestic Agricultural Outlook

Overview

Government progress

Wheat

Corn

Other feed grains

Soybeans

Demand for livestock products

Cattle

Hogs

Poultry

Dairy

Farm Income Outlook

Overview

Farm receipts

Farm expenditures

Net farm income

Financial situation

Special Report

Assumptions

Forecast Tables

Forecasts of:

Trade, prices, stocks, production, harvested area, U.S. and world export price and quantities traded.

Forecasts of:

Prices, production, acres, yields, total consumption, feed use, food use, seed use, livestock numbers, livestock products produced

Forecasts of:

Net farm income, cash receipts, cash expenses, government payments, non-cash expenses, non-money income

Model Overview



The MSU Agriculture Model has three major components

- International
- Domestic
- Farm Income

Forecasts are developed from the simultaneous solution of the international and domestic components of the Model. Regional import demand and export supply estimates from the international component interact with demand and supply estimates from the domestic component, yielding a forecast. U.S. agricultural policy decisions interact endogenously with the supply and demand components. The income accounting component combines forecasts of cash receipts, government payments and other farm receipts with aggregate expenses to provide forecasts of net farm and net cash income.

The primary emphasis in developing the model was specification of the structural relationships within and among sectors. Model developers worked closely with commodity experts to test and validate the intersectoral balances during specification and respecification. Inter-sector balance refers to the relationship of each sector to all other sectors, for example, the relationship of the soybean sector to the feedgrain and livestock sectors. The resulting non-

optimizing model is well equipped to address questions related to producer response to price changes over an intermediate to long-run adjustment period.

Model forecasts undergo the same scrutiny as did model development. Structural changes which cannot be estimated from historical data are introduced in the model in a systematic way. For example, changes in energy costs introduce structural change into the acreage allocation component of the model. This change cannot be observed from the historical data, so technical experts in animal science, agricultural engineering and crop and soil science are called upon to provide technical data needed to estimate the extent of structural adjustment. These changes are then imposed on the model. The change in energy costs was introduced into the model by adjusting the acreage equations to reflect the shift in profitability.

Throughout the model, the focus is on the logical validity of the output as well as on the data inputs. Forecast results are monitored for consistency over time and between sectors. For example, commodity price forecasts are evaluated with respect to forecasts of costs of production.

International Component

The International Component of the MSU Agriculture Model consists of nine regions and covers wheat, coarse grains and soybeans. Production, consumption, net trade and ending stocks are projected for each region, and a simultaneous solution for all regions generates an equilibrium world price. The regions and commodity coverage are shown in Table 1. In total, nearly 120 countries and 95 percent of world grain and soybean trade are included in the model.

The International Component provides the driving force for the entire agriculture model and reflects the importance of world trade to U.S. agriculture. World demand is allocated among exporting countries according to a trade hierarchy which is dependent upon grain availability for export and marketing behavior. This formulation differs substantially from the more commonly used spatial equilibrium model which allocates trade according to transportation costs.

Under the trade hierarchy formulation, countries such as Argentina and Brazil sell as much grain and soybeans as desired, and the unsatisfied world demand is then divided among the remaining exporting countries. The United States is the residual supplier under this formulation, and the model response closely reflects events currently being observed in the market. Figure 2 reflects this trade hierarchy.

World import demand is estimated for each importing region as a function of world prices and the region's population, income, exchange rates and domestic supplies. Government intervention is implicitly included in the estimation of each region's imports. Interaction between the imports of wheat, coarse grains and soybeans are accounted for by cross price as well as direct price affects.

Crop production for each country or region is obtained as the product of separately estimated area

harvested and yield equations. The total area available for grains and soybeans is constrained by a separately specified cropland base equation. This specification ensures that future cropland growth is tied to land availability as indicated by historical trends and expert opinion. Given this cropland availability, the area harvested of each crop is determined by relative prices of the respective commodities. Yields are estimated from historical trends and modified to reflect additional information when such information contributes to explaining crop yields.

Scenarios are used to test the sensitivity of model results to both the rate of growth in cropland and crop yields.

Table 1 — Commodity Coverage of the World Model^a

Countries and Regions	Wheat	Coarse Grains	Soybeans
Exporting Countries			
Canada	X	X	
Argentina ^b	X	X	X
Brazil ^c	X	X	X
Importing Countries			
Soviet Bloc	X	X	X
Developed Market	X	X	X
Less Developed			
Countries	X	X	X
China	X	X	X
Undesignated ^d	X	X	

^aX indicates commodity coverage.

^bParaguay is combined with Argentina to determine soybean exports, but it is included in the Less Developed Countries region for wheat and coarse grain.

^cBrazil is included in the Less Developed Countries for wheat and coarse grain.

^dThe Undesignated region represents wheat and coarse grain trade which cannot be identified. This category represents approximately 5% of world grain trade and is a reoccurring category.

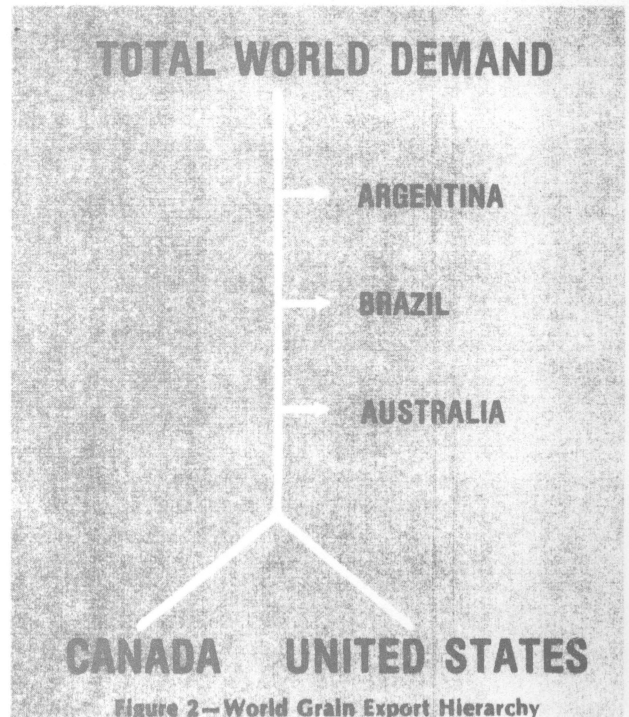
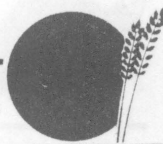


Figure 2—World Grain Export Hierarchy

Domestic Component



The Domestic Agriculture component of the Model generates production, consumption, stocks and prices for major agricultural sectors such as grains, oilseeds, livestock and livestock products. The model also includes a detailed component which deals with government agricultural policy.

The Domestic Component is driven by domestic and export demand. Domestic utilization is price- and income-responsive. The interaction between international and domestic components simultaneously determines export prices, quantities traded, stocks and domestic consumption for the U.S.

The model is especially well suited to the analysis of government policies related to grains and soybeans. A number of specific policy variables are included. These variables are designed to simulate existing government commodity price support, acreage diversion and stock acquisition programs based on program rules. This results in a very flexible and manageable way of incorporating government policy into the model estimates.

Crop production is calculated as

the product of separately estimated harvested acres of soybeans, wheat, corn, sorghum, barley and oats and yield per acre for each crop. Harvested acres are estimated as a function of planted acres, and planted acres are estimated as a function of past crop prices and current government policies.

Four categories of livestock are included in the U.S. supply model: beef, dairy, pork and poultry. Separate estimates are made for each category, and outputs are aggregated after production to estimate feed demand. Some interaction between sectors is incorporated, such as the number of dairy cows held is influenced by the price of beef.

The livestock sector is represented by both producer decision variables and biological response variables. Producer decision variables include the number of animals to sell, the weight at which an animal is slaughtered and the rate of herd expansion or contraction. Biological response variables are determined primarily by such factors as death rates and calving rates. Producer decision variables are econometrically estimated on the basis of

economic factors, while biological factors are obtained from historical records.

Dairy cow numbers are estimated from herd size, replacements, culls and death loss. Heifer replacements are estimated on the basis of milk production profitability and cow slaughter prices. The milk production profitability variable is measured by a gross margin variable which includes milk prices, feed costs, labor costs and technological shifts over time. The gross margin specification incorporates more information in a single variable without reducing the statistical degrees of freedom that would be associated with separately entered variables.

Pork production is determined by the size of the pig crop and the weights of the slaughtered animals. Separate equations are used to represent fall farrowings and spring farrowings. The poultry sector identifies separate turkey, broiler and egg production.

Feed consumption is estimated for coarse grains, soymeal and wheat. Estimates of coarse grain and soymeal feed use are based on grain or meal consumed per standardized animal unit.

Table 3 — Distribution of Total World Grain Stocks^a

Marketing Year	World Stocks	U.S. Stocks	U.S. to World Stocks
	(Million Metric Tons)		(Percent)
1970-71	164.1	55.0	33.5
1971-72	183.1	74.0	40.4
1972-73	142.4	48.0	34.0
1973-74	146.6	31.3	21.4
1974-75	133.0	27.6	20.8
1975-76	141.2	35.7	25.3
1976-77	194.5	61.5	31.6
1977-78	192.7	74.8	38.8
1978-79	219.3	72.5	33.1
1979-80	194.7	78.3	40.2
1980-81	176.8	62.4	35.3
1981-82 ^b	214.5	100.7	46.9
1982-83 ^c	243.0	134.7	55.4

^aTotal Grain includes wheat, coarse grains, and rice.

^bPreliminary.

^cProjected.

om Income Component

The farm income component provides intermediate and long-term forecasts of the farm sector financial position for use in strategic planning by producers, input suppliers and government policy analysts

The farm income and financial outlook incorporates farm income forecasts with the latest developments in agricultural capital markets farm real estate trends, capital expenditures and cash flow analysis. The report highlights major economic events influencing the performance and profitability of the agricultural sector

Net farm and net cash income forecasts are presented in both

nominal and current dollars for a wide range of uses in planning and economic analysis. Some of these applications include developing credit policy guidelines for agricultural financial institutions, and forecasting the demand for capital expenditures and debt capital

The report presents a timely, concise analysis of the financial position of the agricultural sector along with a discussion of likely future trends. Presentation of summary graphs, such as the contribution margin analysis shown in Figure 3, provide concise, easy-to-interpret planning information

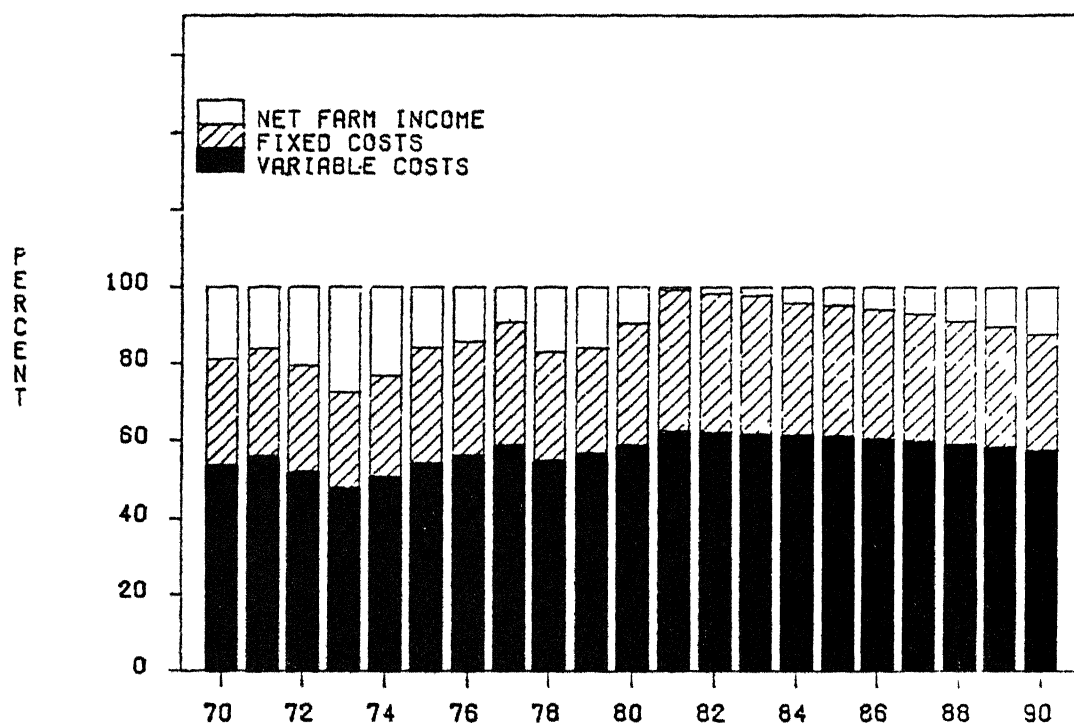
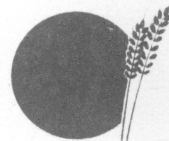


Figure 3—Contribution Analysis of U.S. Income Statement

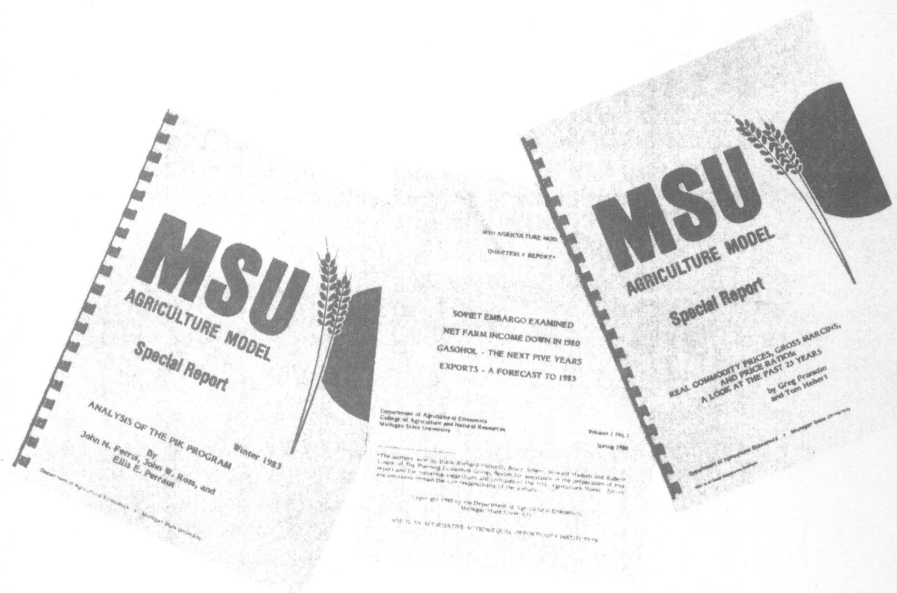
Special Reports and Supporting Services



Special reports and supplemental forecasts are provided in response to major developments in the agricultural economy. For example, 24 hours after the announcement of the Payment-in-kind program (PIK) participation rates on March 22, 1983, the MSU Agriculture Model team published a preliminary analysis of the impact of participation rates on prices, stocks and trade of corn and wheat.

The PIK analysis incorporated simulations from the Model. Two weeks after the first announcement of the PIK Program in January 1983, the MSU Agriculture Model team published an analysis that successfully bounded the rate of farmer participation in the program and provided a simulation of the impact of the program on stocks, production, and prices each year to 1985.

In addition, the MSU Agriculture Model staff will provide economic analysis, scenario building, and simulation runs at the clients' request. For example, in December 1982, the model staff was asked to analyze and simulate the impact of a substantial decrease in the barrel price of oil on agricultural production, prices and farm input demand to the year 1990. Direct simulation runs can usually be provided with a 1-3 day turn around time to meet critical meetings and deadlines.



Recent Topics of Analysis

(Actual analyses are proprietary. This list is provided to indicate the range to topics covered.)

- Analysis of Alternative U.S. Commodity Loan Rates
- The Impact of the Payment-In-Kind Program (PIK)
- The Impact on Agriculture of Crude Oil Price Reductions
- Farm Tractor Sales Forecast
- Alternative Yield Scenarios: The Impact on Export Markets
- Hagadorn Bill and Blended Credit
- Cargo Preference Bill
- E.C. Corn Gluten Meal Import Policy
- Phase Out of the E.C. Variable Levy
- Impact of the E.C. Wheat Export Subsidy
- Impact of LDC Income Growth of Grain Exports
- World Soybean Production
- The Soviet Grain Embargo of 1980

